

REPORT
OF THE
SURGICAL OPERATIONS

PERFORMED AT THE NEWCASTLE-UPON-TYNE INFIRMARY, DURING A
PERIOD OF SEVENTEEN YEARS AND A HALF.

BY SAMUEL FENWICK, M.D.,
LECTURER ON PATHOLOGICAL ANATOMY AT THE NEWCASTLE-UPON-TYNE SCHOOL OF MEDICINE AND
SURGERY.

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REPORT.

PART I.—ON AMPUTATIONS OF THE LIMBS.

THE importance of collecting the results of operations is so obvious, that no apology is required for introducing this paper to the profession. The source from which the facts relative to the Newcastle Infirmary have been drawn, is a register of the various operations performed in the hospital. In each case, the name, age, and trade of the patient are noted, together with the nature of the accident or disease for which the operation was required, the time of its performance, the date of his death or dismissal, and, in the older books, the duration of his illness. Although I have carefully searched through the other registers of the hospital, which have been preserved for nearly a century, I have been unable to find any other notice of operations, excepting a note on the number of cases of lithotomy in the year 1757, and a record of a few amputations about 1812; but, as in these last, neither the time of their performance, nor other circumstances are stated, I have rejected them as useless for statistical purposes. The operation register seems to have been commenced by the late Mr Church, at that time house surgeon to the Institution. The first entries which can be employed are in the year 1823; from that time until May 1843, it has been regularly kept, excepting during intervals of time, which amount, on the whole, to two years. The period, therefore, during which the operations are registered is seventeen years and a half.

As I could only answer for their correctness during the time in which it was my own duty to record these operations, I have carefully compared the results of each, as given by the operation book, with those furnished by the general registers of the hospital, and, with a few trifling and easily explained differences, have found them to agree.

There are a few omissions in the method of drawing out the cases

of amputations in the register of the operations, which it may be as well to mention, as they have deprived them of much of the value they would otherwise have possessed. The first is, that the particular part at which the limb was removed is not usually stated; and the second and still greater omission is, that neither the period at which dangerous symptoms came on after the operation, nor the causes of death, have been regularly noted down. This last is indeed a matter of the utmost importance, as it is only from a proper knowledge of the diseases causing death, that we can anticipate any great improvements in operative surgery.

I had originally intended to publish the results of all the operations performed at this Infirmary in one paper; but finding that the many valuable contributions to this part of science, which have been made during the last few years, had not been brought together, and that many of my medical brethren were still sceptical with regard to the great mortality consequent on amputations, I determined to incorporate the facts obtained at the Newcastle Infirmary with the observations of others. I have therefore collected, as far as the circumscribed limits of a provincial library afforded me the means of doing, the statistical labours of other surgeons, hoping that although the conclusions I have arrived at may not be in all cases satisfactory, yet that these tables may prove of some assistance to others, who, with more time and greater opportunities, may hereafter pursue the subject.

1.—*General Mortality of Amputations.*

The number of amputations performed at the Newcastle Infirmary during the seventeen and a half years, is 435, of which number 59 deaths took place, or 1 in every 7·37; 229 were amputations of the limbs, and 54 of them died, or 1 in every 4·24. Of the 229, there were three persons who suffered amputation of two limbs, and in one case it was necessary to operate a second time, on account of gangrene of the stump; so that only 225 individuals submitted to the operation. Of these, 20 were dismissed as out patients, with their wounds still unhealed at an average period of 61·2 days; the time of cure of those who left the hospital perfectly recovered was 52·13 days; and the average time of death amongst the fatal cases was 15·03 days.

Of the 206 minor amputations 5 died, or 1 in every 41·2; the time required for cure cannot be accurately ascertained, as the greater part of them became out patients immediately after the performance of the amputation, but the average time of death amongst the fatal cases was 25 days.

TABLE I.

General Mortality of Amputations of the Limbs.

Hospital or Authority.	No. of Amputations.	No. of Deaths.	Average Mortality.	Period in which Operations were performed.
CIVIL PRACTICE.				
Liverpool Infirmary,.....	43	3	1 in 14.33	1834 to 1836.
" " (Mr Halton),.....	...	...	— 11.66	22 years.
" " Northern Hospital,.....	96	18	— 5.33	1834 to 1843.
Edinburgh Infirmary,	61	31	— 1.96	3½ years.
Glasgow Infirmary,	276	100	— 2.76	1794 to 1839.
" "	155	47	— 3.29	1841 to 1846.
Six Scotch Hospitals,	24	3	— 8.	1842.
Newcastle Infirmary,	229	54	— 4.24	
Royal Berkshire Hospital,	27	5	— 5.4	1838 to 1845.
Chester Infirmary,.....	21	9	— 2.33	1838 to 1841.
University College Hospital,	66	10	— 6.6	1835 to 1841.
Guy's Hospital,	36	4	— 9.	1843 to 1845.
Great Britain (Mr Phillips),	233	53	— 4.39	
Collected from various Journals (Mr Phillips)	308	76	— 4.05	
Notes of various Surgeons (Mr Phillips), ...	107	28	— 3.82	
Various Surgeons (Dr M'Hardy),.....	364	83	— 4.38	
Total of British Practice,.....	2046	524	1 in 3.9	
Massachusetts General Hospital,.....	67	15	1 in 4.46	
Pennsylvania Hospital,.....	79	22	— 3.59	
America (Mr Phillips),.....	95	24	— 3.95	
Total American Practice,	241	61	1 in 3.95	
Germany (Mr Phillips),	109	26	1 in 4.19	
France (Mr Phillips),.....	203	47	— 4.31	
Hotel Dieu,	35	17	— 2.05	1840 to 1842.
"	178	104	— 1.71	1836 to 1842.
Hospitals of Paris (Malgaigne),	552	300	— 1.84	1836 to 1841.
Paris (Gendrin),	63	23	— 2.73	1834.
Paris (Dupuytren),.....	59	15	— 3.93	
Total of Continental Practice,.....	1199	532	1 in 2.25	
Total of Civil Practice,	3486	1117	1 in 3.12	
MILITARY PRACTICE.				
Army at Algiers,	63	17	1 in 3.71	1837 to 1840.
Baron Percy,	92	6	— 15.33	
New Orleans,	52	12	— 4.33	
Naval Action of June 1, 1794,.....	60	8	— 7.5	
Bombardment of Algiers,	59	24	— 2.45	
British Army in Peninsula,.....	842	289	— 2.91	
British Army at Thoulouse,	100	31	— 3.22	
Other Military Records (Alcock),	74	6	— 12.33	
British Legion,	109	55	— 1.98	
Total of Military Practice,	1451	448	1 in 3.23	
Total of Civil and Military Practice,	4937	1565	1 in 3.15	

The assertion that one person out of every three who suffers an amputation perishes, would have been repudiated a few years ago as a libel upon our professional value; and yet such is the rate of mortality observed in nearly 5000 cases.

It is a striking illustration of the necessity of accurate calculations, that we find a celebrated hospital surgeon supposing that only 1 out of 20 died after this operation; whereas the general result of British civil practice, in more than 2000 cases, shows an average mortality

of 1 in 4; and how shall we reconcile the returns of military surgery with the boasted success of many of our military authors?

Upon observing how much the average mortality differs in different infirmaries, even in the same country, as from 1 in 14·33 at Liverpool to 1 in 2 in the Edinburgh Infirmary, we might be tempted to suppose, that these returns would enable us to estimate the healthfulness of the hospitals, or the relative skill of their medical officers. Such a supposition, however, will, upon a little reflection, be seen to be incorrect.

Two surgeons may each have six cases of gangrene; one may wait until a line of demarcation has formed in them all, may operate upon three of them, and save but two; the other may amputate the limb in every case, and only three may recover. Now, it will be evident that although the latter has, by his boldness, preserved the life of one more person than his more timid colleague, yet in estimating only the success of the operations, whereas in those of the former the average mortality would be but 1 in 3, that of the latter would amount to 1 in 2. It is, I conceive, partly from this reason, that, in looking over the operations of the Newcastle Infirmary, I have so seldom found the apparent success of any of our most celebrated surgeons commensurate with his reputation; but, on the contrary, have often observed those who have enjoyed the greatest name, number the largest amount of deaths amongst their patients. Again, as it will be afterwards proved that a vast difference in mortality exists according to the disease for which the operation is performed, and that traumatic amputations are much more fatal than those required for pathological causes, the practice of any hospital may appear peculiarly successful from its situation in an agricultural district, although, if more minutely examined, the results of its operations may be really less favourable than those of another placed in the midst of a mining or manufacturing population. These considerations are of no small importance, as I have known practitioners hesitate to publish reports which exhibited a high state of mortality; and, in more than one instance, may we see very creditable papers on operative surgery, whose merit is lessened by quotations from other works, inserted to exhibit the superior success of the hospital with which the writer is connected. But, although it is highly useful to have an accurate idea of the general results of amputations, we must be careful not to employ such knowledge to purposes to which it cannot properly be applied. We should remember, that in every operation its value to the patient should be alone considered; and the above figures, whilst they show the general success consequent on the labours of the surgeon, cannot be used to estimate the chances of any particular individual who may be placed under his charge. An attempt has been made to sanction other operations, by comparing their results with those of amputations; and, were the reputation of the surgeon the only matter for consideration, no better means could be employed for that purpose; but as it is the value to

the patient which is to be estimated, the matter must be viewed in a very different light. Thus, although one out of every four cases of removal either of an ovary or a limb may die, the value of the operation will be very different to the persons suffering from the complaints requiring the performance of these operations. The one has to weigh against the dangers of extirpation, a considerable chance of two or three years' existence, and a comparative freedom from pain during that time; whilst, in the other, a speedy death or great suffering is all that can be expected, unless by amputation the affected part be removed.

It is a matter of great importance to ascertain at what time after an operation there is the greatest danger to life, so that especial care may be used to defend our patients from the attacks of disease at that particular period. Many seem to imagine, that, notwithstanding the light that of late years has been thrown upon the causes of death after operations, the shock is chiefly to be dreaded; and, in conversation, usually speak of an amputation as likely to be successful, if the patient have surmounted the first depression of the operation, or of the injury for which the limb was removed.

The next table shows, however, that in the second week after an amputation, there is a very great danger of the patient being attacked by disease, and that, until he has passed the 14th or 21st day, we cannot consider his chance of recovery even tolerably good. This table has been constructed so as to exhibit the number in each period of which 1 person perished; as, for instance, at the Newcastle Infirmary, one died out of twelve in the first week, and one in fifteen in the second. To form it, the whole number of amputations were divided by the number of deaths that occurred in the first week, so as to give the average mortality in it: These deaths during this first week were then subtracted from the whole number of operations, and the remainder again divided by the deaths during the second week, so as to give its mortality. The calculations for the Glasgow Infirmary were made in the same manner, from the times at which the cases of amputation died, as given in Dr Lawrie's valuable paper in the Medical Gazette for December 1840.

TABLE II.

Showing the number of Cases of which 1 has died in each week after Amputation of the Limbs, in the Newcastle and Glasgow Infirmaries.

Hospital.	WEEKS.								
	One	Two	Three	Four	Five	Six	Seven	Nine	Fourteen.
Newcastle Infirmary, .	12·33	15·69	27·28	26·28	59·	...	174·	173·	...
Glasgow Infirmary, ...	5·79	12·63	16·	30·	38·66	37·66	55·	...	108·

As the average time required for the recovery of those persons who were dismissed cured, was found to be in the Newcastle Infirmary upwards of seven weeks, it is evident that, after an amputation, a tendency to fatal diseases is set up, which, after a certain lapse of time, declines, whether the wound produced by the knife be healed or not; for were this not the case, the amount of deaths would be more equal in the second, third, and fourth weeks, than it appears to be in Table II. It is also somewhat remarkable, that although, in the Glasgow Infirmary, 1 out of 16 died in the third week after an amputation, and only 1 in 27·28 in the Newcastle Infirmary, yet that the time of cure in the former was only forty-two days, whilst in the latter it extended to fifty-two days. It is worthy of observation, that, whilst in Glasgow, the mortality in the first week was 1 in 5·79; at Newcastle, it was only 1 in 12·33. This difference, I conceive, arises from the greater proportion of traumatic operations in the practice of the former hospital, and, in order to illustrate this opinion, I have added the average mortality which took place at both hospitals in the first seven days after the amputations.

TABLE III.

Showing the Number of Cases of which 1 has died in each day, within the First Week after the performance of Amputation of the Limbs, at the Newcastle and Glasgow Infirmaries.

Hospitals.	DAYS.						
	One.	Two.	Three.	Four.	Five.	Six.	Seven.
Newcastle Infirmary,.....	74·	31·28	106·	105·	208·	...	69·
Glasgow Infirmary,	24·	53·7	26·3	76·	30·	48·3	47·3

The difference is here exceedingly striking, more than three times the number having sunk during the first twenty-four hours in the Scotch Hospital; and although, in the following day, the amount of deaths has been greater at Newcastle, yet, in the succeeding periods, we still find a much greater fatality in the former. In order, however, to make these figures of any practical use, we must ascertain the nature of the affections producing death; and, not being able to bring forward any statistical statement from the Newcastle Infirmary on this point, I have collected the accounts of as many *post-mortem* examinations as are reported in the various records before quoted. The number of deaths amounts to 138, and the causes are as follows:—

TABLE IV.

Showing the Number of Deaths caused by different Diseases after Amputation of the Limbs, their proportion, and the number of Cases which may be expected to Die from each Class of Diseases in every 500 Amputations which may be performed in the Civil Hospitals of Great Britain.

	No. of Deaths.	Proportion to the total number of Deaths.	Proportion in 500 Amputations in British Civil Practice.
Shock, exhaustion, and delirium,.....	23	1 in 6·	} 27·82
Gangrene of stump,.....	7	" 19·71	
Secondary hemorrhage,.....	4	" 34·5	
Tetanus,.....	4	" 34·5	} 3·89
Erysipelas,.....	6	" 23·	
Visceral inflammations,.....	21	" 6·57	
Diseased viscera,.....	6	" 23·	} 80·62
Purulent deposits,.....	29	" 4·75	
Phlebitis,.....	20	" 6·9	
Phlebitis and purulent deposits,.....	5	" 27·6	} 12·07
Diarrhœa and hectic,.....	12	" 11·5	
Bed sores,.....	1	" 138·	
	138		

Here, then, are a number of diseases following amputation, differing both in their nature, in the organs they attack, and in the amount of death they produce. We observe some causing only one fatal result in every 34 deaths, whilst another appears to be the means of terminating life in one-fourth of the unfortunate cases of the operation. We before observed, that the operators connected with the largest Hospitals, had to lament a considerable number of their patients carried off by death after amputations; and we now see, by glancing over this table, how little manual dexterity can influence their success.

And, yet, works upon operative surgery are daily written, which detail with the greatest accuracy the formation of flaps, and lay down to a hair's breadth the extent of incisions, without mentioning the secondary affections liable to occur after the operation. Huge dictionaries issue from the press, discussing the rival merits of ancient authorities to some trifling improvement in the method of amputating, but forgetting to lay down rules for the prevention or detection of the many dangerous diseases which so often follow its performance. How many Hospital surgeons seem to imagine that the necessity for their personal attention to a case of amputation, terminates at the door of the operating theatre, and leave the after treatment to be solely directed by a house surgeon or a dresser! How many content themselves with a hurried inspection of the pulse and tongue of the patient, after an amputation, instead of exploring the chest, or watching for the first indication of phlebitis; and how many young practitioners do we not find, who speak of an amputation as though the interest connected with it ended with the operation, and as though success were certain if the patient surmounted the shock, or be unaffected with hemorrhage!

These causes of death may be readily classified: thus, 30 out of 138, or 1 in 4·6 died from the shock, in one form or another. In these cases, the death seems to result from the sympathy of the nervous

system with the part of the body which is injured, no anatomical alteration of the nervous centres being perceptible on *post-mortem* examination.

I have included under this head, delirium and gangrene of the stump. The former is usually observed as following accidents and operations in persons of intemperate habits; but occasionally I have seen it as a consequence of shock in the case of healthy and temperate individuals, and have observed it to destroy life within one or two days after the operation. Gangrene, if it be not the re-appearance of the disease which necessitated the removal of the limb, is, in most cases, produced by want of power in the system, and may, therefore, be appropriately classed as the result of exhaustion. Supposing, then, that these numbers represent the usual amount of death, we should expect that, out of every 500 amputations, upwards of 27 would perish from this class of diseases.

Secondary hemorrhage in civil practice, although it is stated to occur once in every 13 cases of amputation, is nevertheless an infrequent cause of a fatal termination; only 4 deaths out of 138 being referrible to it. In military practice it seems more frequent: thus Mr Alcock estimates its occurrence, according to his own observation, as taking place once in every five amputations, and as causing death in 5 in 109 cases. I am unable to bring forward any statistical statement of its frequency at the Newcastle Infirmary; but am inclined to imagine that the proportion of 1 in 13, quoted from Dr M'Hardy, would be about the average of its occurrence; and yet, during the seven years that I lived within the Hospital, no death was caused by it. In the Operation Register, a case is mentioned as having taken place twenty years ago, in which amputation was performed on an old man on account of ulceration of the leg; the arteries were found ossified, and gave way in the application of ligatures; a considerable amount of blood was lost; and although, finally, the femoral artery was secured higher up in the thigh, the patient sank on the third or fourth day after the operation.

In the diseases we have just mentioned, we cannot perhaps anticipate any great improvement in our means of cure; for we may always expect that a certain proportion of those undergoing amputation will be in such a state of health at the time of its performance, that death will ensue from exhaustion. Perhaps, as our science improves, the mortality from shock may rather increase, as in many cases we may be inclined to give a chance of life, where now we leave the patient to his fate. But it is widely different in the class to which we have next to direct our attention: it consists of diseases of various parts of the body, attended with alterations of their structure, appearing some days or weeks after the operation, and, when fully developed, usually proving fatal to the patient:—91 out of 138 deaths took place from them, which is in the proportion of 84 deaths in every 500 amputations. It may seem strange, that in this class I have included tetanus; but although it is frequently considered a

functional disease, yet there is, I think, considerable probability, that at some future time some structural change will be discovered in the spinal chord. Although only 1-34th of the number of deaths occurred from it, there is every reason to suppose that even this amount is above the general average in this country, and that some of the above were cases, in which removal of an injured limb had been unavailingly tried as a means of stopping the symptoms of the complaint.

It speaks well for the management of the Hospitals, from which these numbers are taken, that so small a proportion as only 1 in 23 deaths has arisen from erysipelas.

Judging from my own observation, I fear we should have had to reckon a somewhat larger number had the causes of death at the Newcastle Infirmary been added to this table, as it has frequently appeared in the wards, and, on more than one occasion, I have seen persons sink from it after submitting to operations of a trivial character.

We find that 27 had died of visceral inflammations and diseases, or in the proportion of 25 in every 500 amputations. We can more readily explain how an attack of erysipelas may take place, than by what means an inflammatory affection of the internal organs occurs after the removal of a limb. Almost every organ has, however, been found diseased after amputation, though chiefly those which contain the largest amount of blood in a state of health, as the lungs and liver. Some persons have believed, that in these visceral inflammations the organs affected had been previously unhealthy, and that the operation had only acted by rousing the latent disease into fatal activity. I have certainly observed some cases which supported this view in a most striking manner; but the large proportion of individuals so affected after operations, must at once overthrow the idea of this being the general cause of their production. Others have attributed them solely to the ordinary exciting causes of inflammation acting upon a habit enfeebled by chronic diseases; but this theory must also fall to the ground, as it will be afterwards shown, that whereas, in amputations from pathological causes at the Newcastle Infirmary, only one died out of every 5·14, one died out of every 3·11 in those performed for accidents. It has been surmised by others, that the depression of the shock is the usual cause of these complaints, by producing a typhoid condition of the system, and that, in proportion to the amount of shock, is the danger of the occurrence of secondary inflammation.

In support of this opinion may be quoted the fact, that traumatic amputations, which are most liable to death from shock, are also most subject to visceral diseases.

But this opinion appears to be disproved by the following facts:—In Table X., it will be seen that in the Glasgow Infirmary, although the deaths from shock were one in every 12·8 in the primary, and one in every 6· in the secondary amputations, the mortality in both from secondary inflammations was nearly equal; and, in Mr Alcock's practice, one in every 8·66 died from shock in the secondary, and

only one in every 57 cases of the primary amputations, and yet no instance of phlebitis or disease of the viscera was observed in the former; whilst 1 in 9·5 died from phlebitis, and 1 in every 3·56 of disease of the viscera in the latter. And again, in Table XXXVI. it will be observed, that, between 10 and 20 years of age, the mortality during the period of shock is 1 in 2, and yet no deaths had taken place out of 4 after the first week; whilst, amongst those between 20 and 30 years of age, although the mortality was only 1 in 12 in the first week, it amounted to 1 in 2·75 after that time.

The truth, I imagine, will be found to be, that the exciting causes of these secondary diseases are various; but that a predisposition is given to inflammatory diseases by the removal of any large portion of the body. For, after this operation, the heart and arteries will contain more blood than is required for the body, whilst a less proportion of venous blood will be formed, on account of its passing through a smaller extent of the capillary system; and, therefore, this fluid will be more highly stimulating than it should be in a state of health, especially when the patient has not been reduced by previous illness. We should also add to this predisposing cause those above mentioned; viz., that where previous disease has existed, it will be liable to be brought into activity by the state of the patient after the operation; and also, that after a certain length of time, if the patient be much weakened, either by fever or by discharge, pneumonia will be as likely to take place as it usually is in other persons in a similar state of health, but in whom it is produced by any other predisposing cause.

It is only within the last few years that any satisfactory explanation has been given of the occurrence of purulent deposits, in different organs of the body, after an accident or operation. The passage of pus into the circulation has, however, been proved to be the general cause of this fatal form of disease; and the further the subject is investigated, the more are we surprised at the frequency with which it takes place after operations.

More than one-third of the whole number of deaths after amputation, seem to have arisen from this cause. I have included purulent deposits and phlebitis under one head, as in the majority of cases the former result from the latter; and often, where the more obvious diseases of the viscera have alone attracted the attention of the pathologist, there is every reason to believe the primary cause of death had been overlooked, from want of due care in the examination. When, however, we reflect upon the disposition of veins to inflammatory action, we need not be surprised that it so frequently follows amputation. We see phlebitis set up idiopathically, we observe it arising from the passage of a catheter, from small scalp wounds, from an issue near a vein, and from many other equally trivial operations; and how can we expect that these vessels will remain unaffected in the inflammatory attacks of the stump, which are so often observed after the removal of a limb? We should likewise remember, that, in taking up the smaller arteries, the accompanying veins must be

frequently included in the ligatures, which, of itself, is sufficient to give rise to the disease. Besides, occasionally, ligatures are placed upon the larger veins through carelessness; thus, I have seen a surgeon of great experience tie the femoral vein on account of a little bleeding, which by other means might have been stopped, and urge as an excuse for his conduct, that, notwithstanding what had been written upon the subject of phlebitis, he had often adopted the plan without any unpleasant results.

The small proportion of deaths from secondary exhaustion, as from hectic, diarrhœa, &c., is very remarkable when contrasted with the large number caused by inflammatory affections. Only $\frac{1}{10}$ th of the whole number of deaths is referrible to this class, or of 500 amputations in British civil practice, we may expect but 12 to perish from this class of diseases. Even this proportion is perhaps a little too high, as, under the head of diarrhœa, I may have included some who have sunk rather from muco-enteritis than from exhaustion; since in the next table it will be shown, that 2 of the deaths from this cause occurred at an early period after the operation.

That the surgeon should be acquainted with the proportion in which these diseases appear after an amputation, is of obvious importance; but the value of this knowledge is greatly increased, if he is also aware of the time at which each is most liable to occur. In order to assist in attaining this, I have added the following table, drawn up from the report of Dr Lawrie.

TABLE V.

Showing the Number of Deaths which, at the Glasgow Infirmary, had taken place from various Diseases, at different periods, after Amputation—calculated from Dr Lawrie's Table.

	Within 4 days.	4 to 7 days.	2 weeks.	3 weeks.	4 weeks.	5 weeks.	6 weeks.	7 weeks.	14 wks.
Shock, exhaustion, and delirium,.....	7	...	...	...	...	...	...	...	...
Secondary hemorrhage,	3	...	...	...	...	...	...	1	...
Gangrene of stump,	4	2	...	...	...	...	...	...	...
Tetanus,	1	...	...	...	...	...	...	...	...
Erysipelas, .....	...	2	1	1	...	...	...	...	...
Visceral inflammations,	1	2	2	2	...	1	1	...	1
Rigors, phlebitis, and purulent depos.	1	4	6	4	4	2	1	1	...
Diarrhœa,	1	1	2	1	...	...	...	...	...
Bed sores, .....	...	...	...	...	...	...	1	...	...
	18	11	11	8	4	3	3	2	1

At different periods after an amputation, different diseases are liable to occur. Thus, taking the first period of 4 days for our consideration, and rejecting tetanus, which appears to have been the cause and not the consequence of the operation, we find, that out of 17 deaths, only 2 or $\frac{1}{8}$ th of the whole had died from organic diseases, 1 had perished from diarrhœa, and the remainder were cut off, either by the shock of the operation, or by hemorrhage. The first 4 days after an amputation may be therefore termed the period of shock, or that in which the danger from primary exhaustion is chiefly to be dreaded; and the number dying in it should always be stated in any report where the real causes of death cannot be ascertained.

Although after the 4th day the influence of shock is to be but little dreaded, yet 2 deaths from gangrene occurred in the next period, one on the 5th and the other on the 7th day, after which no other from the same cause is recorded. If, then, a patient have survived the 4th day, our fear of his death resulting from the exhaustion of the shock, or from delirium, may as a general rule subside, and after the 7th day we need not even dread the secondary effects of the shock in the shape of gangrene of the stump. But after the 4th day a new class of diseases attains a greater prominence than before, and in this class we first observe 2 deaths from erysipelas.

Now, although we see persons die from this affection at all periods after an amputation, yet it will, I think, be found that the general time for its attack is during the first or second week. In this report no death from erysipelas had taken place after the 17th day. We observed, that even by the 4th day cases of death from phlebitis and visceral diseases had occurred, but there were only two during the first 4 days; whereas, after the shock of the accident or operation has subsided, these affections are so rapidly produced, that between the 4th and 7th days no fewer than 6 deaths are registered as produced by them. From this time they gradually decline in frequency, the next period of 7 days showing only 8 deaths, and the third week only 6. But, if we consider the mortality produced by them in another point of view, we find it is as great in the second as in the first week, and that the surgeon has as great a chance of losing his patient from this class of diseases, after the 14th day, as before that time. It may be likewise remarked, that even in the 14th week a case of death had taken place from visceral inflammation; and as these diseases are most frequent in hospitals, it may be suggested, that as soon as the condition of the patient will admit of it, he should be removed to a less crowded residence than the ward of an infirmary.

The proportion of deaths from diarrhœa is very large in this report, and Dr Lawrie classes it among the secondary inflammations, a classification which the time at which it produced death certainly appears to favour. If I were to judge from my own experience, I should be inclined to say, that, in most hospitals, diarrhœa is both a more unfrequent cause of death than here stated, and that it usually takes place at a later period after the operation.

2.—*The success of an Amputation varies according to the part of the limb at which it is performed.*

In order that statistical researches may be applied to direct our prognosis, it is necessary that every circumstance connected with the facts should be considered. Thus to know that one out of every four who suffer amputation perishes, is interesting as giving us a definite idea of our success; but it does not enable us to declare the chance of life which any particular patient can be expected to possess. To do this, we must collect all the favourable and un-

favourable points connected with each case, and then, by ascertaining the results of a number agreeing in these particulars, we shall be able pretty accurately to define the probable chance any patient suffering amputation, when placed under the same circumstances, will have.

These remarks should be borne in mind when we look at the mortality following each amputation, lest we should draw from it erroneous conclusions.

As I was unable to give the real average of success at the Newcastle Infirmary, from it not being usually mentioned at what part of the limb the operation was performed, I have contented myself with the approximative statement contained in Table VI.

TABLE VI.

Showing the success of the Amputations at the Newcastle Infirmary, when they are classified according to the part at which the Accident or Disease existed which required their performance.

	No.	Dead	Average Mortality.	Av. time of Cure.	Av. Dismissal as O. P.	Av. time of Death.
Amput. for injuries and diseases of thigh and knee,...	58	14	1 in 4·14	51·1	67·8	12·28
Do. do. leg and ankle,.....	112	29	" 3·86	54·9	55·1	17·
Total of lower extremity,	170	43	1 in 3·95			
Amput. for injuries and diseases of arm and elbow,...	40	7	1 in 5·71	50·8	93·	17·42
Do. do. fore arm and wrist	15	4	" 3·72	42·54	---	6 25
Total of upper extremity,	55	11	1 in 5·			

TABLE VII.

Showing the Mortality after Amputations at different parts of the Lower Extremity, as observed in various Hospitals.

AMPUTATIONS OF LOWER EXTREMITY.

Hospital or Authority.	Hip Joint.			Thigh.			Leg.			Knee Joint.		
	No.	Dead.	Aver. Mort.	No.	Dead.	Aver. Mort.	No.	Dead.	Aver. Mort.	No.	Dead.	Aver. Mort.
Liverpool Northern Hospital,.....	29	4	*7·25	40	9	4·44	...	...	...
Edinburgh Infirmary,.....	25	11	2·27	12	4	3·	...	...	...
Glasgow Infirmary (Lawrie),.....	1	...	...	128	46	2·78	62	30	2·06	...	...	...
Glasgow Infirmary,	50	18	2·77	48	14	3·42	1	1	1·
Five Scotch Hospitals,	6	2	3·	7	...	0 in 7	...	...	...
Royal Berks Hospital,.....	12	5	2·4	4	...	...	...	...	...
Chester Infirmary,	13	5	2·6	6	4	1·5	...	...	...
University College Hospital,.....	22	4	5·5	26	4	6·5	...	...	...
Dr M'Hardy,	202	56	3·6	55	11	5·	...	...	...
Liverpool Infirmary,	11·	...	...	6·	...	...	...
Massachusetts and Pennsylvania Hospital,	50	15	3·33	49	12	4·08	...	...	...
Hotel Dieu (M. Roux),	16	10	1·6	12	5	2·4	...	...	...
Do. (1836 to 1841),	63	43	1·46	...	...	...	...	...	...
M. Malgaigne,	1	1	1·	201	126	1·57	192	106	1·81	9	7	1·28
Mr Alcock,.....	43	27	1·59	11	4	2·75	...	...	...
Lyons Military Hospital,	4	3	1·33	5	3	1·66	...	...	...
Paris Military Hospital,	5	1	5	5	3	1·66	...	...	...
Various Authorities,	1·42	...	...	...	...	...	...	...	...	...
			1·42	869	376	2·31	534	209	2·55	10	8	1·25

* Whenever the term "average mortality" is employed in these tables, the figures placed under that head must be understood as showing the number of

TABLE VIII.

Showing the Mortality after Amputations at different parts of the Upper Extremity, as observed in various Hospitals.

AMPUTATIONS OF UPPER EXTREMITY.

Hospital or Authority.	Shoulder Joint.			Arm.			Fore Arm.		
	No.	Dead.	Av. Mort.	No.	Dead.	Av. Mort.	No.	Dead.	Av. Mort.
Liverpool Northern Hospital,	2	1	2·	17	4	4·25	7	...	0 in 7
Edinburgh Infirmary,	3	2	1·5	1	...	0 in 1	2	1	2·
Glasgow Infirmary (Lawrie),	6	3	2·	53	21	3·52	22	...	0 in 22
Do. Do.,	8	3	2·66	16	5	3·2	17	3	5·66
Five Scotch Hospitals, .....	...	...	...	4	...	0 in 4	5	...	0 in 5
Royal Berks Hospital,	3	...	0 in 3	4	...	0 in 4	4	...	0 in 4
Chester Infirmary, .....	...	...	...	2	...	...	...	...	...
Massach. & Pennsylv. Hosp.,...	2	1	2·	15	2	7·5	21	1	21·
Hotel Dieu (M. Roux), .....	...	...	...	3	2	1·5	4	...	...
Dr M'Hardy, .....	...	...	...	54	14	3·85	53	2	26·5
Mr Alcock,	10	2	5·	38	19	2·	9	4	2·25
M. Malgaigne,	14	11	1·27	91	41	2·21	23	8	3·5
University College Hospital, ...	1	...	...	8	2	4·	8	...	...
Lyons Military Hospital,	2	1	2·	7	6	1·16	1	...	...
Paris Do. Do.,	2	1	2·	4	2	2·	...	...	...
Newcastle Infirmary,	5	2	2·5	...	...	...	...	...	...
	58	27	2·14	317	118	2·81	181	19	9·52

It is obvious that, however the practice at various hospitals may differ, their returns all agree in displaying a greater mortality after amputations of the lower extremity than after those of the upper.

The removal of a limb at the joint seems much more dangerous than when the bone is divided: thus, we find 8 died out of 10 on whom amputation at the knee joint was performed; whilst, according to the statement of Malgaigne, in the hospitals of Paris, only 1 died out of 1·81 when the operation took place below the knee, and only 1 in 1·57 when performed above it. Again, after amputations at the shoulder joint, the mortality is greater than after those of the thigh or of the leg, and it is much more than what is observed after the removal of the arm at any other part. We have not sufficient numbers to decide whether it is safer to remove the fore-arm above the wrist, or at the joint, no death having occurred of 7 operations performed at the latter, and the average mortality of amputations above the joint being only 1 in every 9·52. The only case recorded in these hospitals of removal at the ankle joint terminated fatally.

cases of which one has died; thus, in Table VII., the average mortality following amputations of the thigh, is stated to be 7·25 in the Liverpool Northern Hospital, and 2·27 at the Edinburgh Infirmary, the meaning of which is, that one person has died of every 7·25 on whom amputations of the thigh have been performed in the former, and that 1 has perished of every 2·27 cases of the same operation at the latter hospital. The figures placed under the heads of "average time of cure," "average time of dismissal as out patient," and "average time of death," show the number of days that each person, on an average, was dismissed from the hospital, or died after the performance of the operation.

When we consider the shock produced by the removal of the whole of the lower extremity, the vast size and number of the vessels and nerves divided, their contiguity to the important viscera of the abdomen, and the general disarrangement which all the functions of the body must experience from the loss of so large a portion of the frame, we should rather feel surprised that so many had recovered, than that so large a number had perished after amputation at the hip joint, and should view the success of this operation as one of the proudest triumphs of operative surgery.

The small difference between the mortality following amputations of the leg, and that succeeding those of the thigh, is well worthy of notice; that of the former being 1 in 2·55, that of the latter 1 in 2·31. In some instances, indeed, as at the Liverpool Northern Hospital, and at the Glasgow Infirmary, the advantage has been with the thigh operations.

The conclusion would appear therefore inevitable, that if amputations, in general, greatly decrease in danger the further they are performed from the trunk, there must be some peculiarity in the structure of the parts divided in amputations below the knee, which renders this operation an exception to the general rule. But if we examine the matter more closely, we shall discover the cause of this apparent exception, in the fact that a greater number of more fatal diseases require amputation of the leg than of the thigh. Thus, if we take the results of the operations performed for diseased joints and bones alone, we find a mortality of 1 in 4·91 after amputations above the knee, and only 1 in 10·33 in those performed below it; or, if we compare those required for accidents, it is 1 in 1·55 in the former, and 1 in 1·93 in the latter. Here, then, are evident proofs that the exception is more apparent than real, and it shows us the necessity of caution in drawing conclusions from statements of a general nature.

The amputation below the knee is usually considered an exception to the general maxim, that no more of a limb should be removed than is absolutely necessary, and the part usually selected for its performance has been named the point of election. But while we consider that the mortality after an amputation decreases in proportion to the distance from the trunk at which it is performed, doubts naturally arise in our minds respecting the propriety of unnecessarily removing any portion of the body, more especially as it is not impossible, that some cheap description of artificial leg might be invented for those submitting to the operation above the ankle, which might be equally convenient with that usually worn upon the stump below the knee. But what are the results of these two operations, viz., that below the knee, and that above the ankle?

We have found the average mortality in the former to be 1 in 2·55, whereas in 9 supra-malleolar amputations only 2 of the patients

died, or 1 in every 4·5. In addition to this statement, MM. Arnal and Martin, of 97 cases of supra-malleolar amputation, state the number of deaths to have been only 1 in 10. Before, then, the surgeon amputates for a diseased foot or ankle joint, let him fancy himself to be the patient, let him coolly consider the figures just quoted, and calculate the different chances of death to which these two operations would expose himself. And then, if he can believe the greater inconvenience of the lower operation to outweigh its greater comparative safety, let him advise his patient to submit to the removal of the limb at the usual point of election. In the upper extremity, as we before remarked of the lower, the mortality decreases according to the distance at which it is performed from the trunk. Thus, 1 died in 2·14 after amputations at the shoulder joint, 1 in 2·81 after those above the elbow, and 1 in 9·52 after those of the fore-arm. Another fact is also observable in the operations on both extremities, viz. that the decrease in the number of deaths is not in any regular ratio; for had the mortality, after removal of the fore-arm, borne the same proportion to that following amputation of the arm, that the mortality of this latter does to the mortality following the shoulder joint operation, it would have been 1 in 3·68, whereas we find it only one-third of that amount, or 1 in 9·52.

It becomes us next to inquire to what causes of death each amputation is most liable, and to elucidate this point I have added the next two tables. The first is calculated from the cases contained in the register of the Newcastle Infirmary, the other is formed from the papers published by Dr Lawrie. This last table has been formed in the following manner:—He has stated the number of those who died after removal of the leg, and the causes of whose death he has been able to ascertain, to be only 20; whereas the whole number submitting to that amputation at the Glasgow Infirmary was 62, of which 30 perished. Now, according to this rate of mortality, the 20 whose immediate cause of death is registered, would represent 41 amputations. This number 41, I have therefore divided by the number of deaths caused by each disease, so as to show the mortality produced by each affection. The other divisions of the same table have been calculated in a similar manner.

TABLE IX.

Showing the number of Amputations, of which 1 died, at different periods after the performance of Amputations at different parts of the Limbs.

NEWCASTLE INFIRMARY.

	Within 4 Days.	4th to the 21st Day.	After the 21st Day.
Amputation for diseases and injuries of Knee and Thigh,	1 in 11·6	1 in 11·6	1 in 14·5
Do. do. Leg and Foot,.....	" 22·4	" 6·58	" 16·
Amputation at Shoulder Joint,.....	" 2·5	...	...
Do. for diseases and injuries of Arm and Fore-arm,	" 50·	" 6·25	...

TABLE X.

Showing the average Mortality which took place at the Glasgow Infirmary from different diseases, the Amputations being separated according to the part at which, and the cause for which they were performed.

	Thigh.	Leg.	Shoulder	Arm.	Accidents.	Diseases.	Primary Amputat.	Secondary Amputat.
Shock, exhaustion, and delirium,	9·7	...	...	20·	8·83	...	12·8	6·
Secondary hemorrhage,	24·25	...	...	...	53·	37·	...	21·
Gangrene of stump,	24·25	20·5	...	...	17·66	...	16·	21·
Erysipelas,	97·	...	...	13·33	26·5	...	21·33	42·
Inflammation of viscera,	16·16	8·2	...	20·	10·6	24·6	10·6	10·5
Phlebitis and purulent deposits,	19·4	3·41	2·	5·	6·23	7·4	5·81	7·
Diarrhoea,	32·33	41·	...	40·	35·3	37·	32·	42·
Bed sores,	97·	...	...	...	106·	...	...	42·
Tetanus,	97·	...	...	...	106·	...	64·	...

At the Newcastle Infirmary we find, that in either extremity the nearer the amputation is performed to the trunk, the greater is the mortality during the first four days, or in that period in which we before found the results of shock were chiefly to be dreaded.

Omitting the amputations at the shoulder joint, as too few in number, we see that the danger from shock is greatest after the removal of the thigh; the average mortality in this operation being 1 in 11·6, in that of the leg 1 in 22·4, and in that of the upper extremity 1 in 50, during the first 4 days. The same conclusions may be deduced from the statements of Dr Lawrie; for, according to Table X., the average mortality from shock, was in the thigh operation 1 in 9·7; no death took place after amputation of the leg of 41 cases, and only 1 in 20 after that of the arm. Mr Alcock also gives the causes of death in 21 cases, of which 3 died from shock or exhaustion; of these 2 were amputations of the thigh, and the part at which the third suffered the operation is not mentioned.

Gangrene, which does not appear to have produced a fatal result in any amputation of the upper extremity, was the cause of death at the Glasgow Infirmary, of 1 case in every 24·25 of the thigh operation, and of 1 in every 20·5 of the leg.

We might have anticipated that secondary hemorrhage, occurring after amputations of the thigh, would prove peculiarly fatal, both on account of the greater size of the vessels, and also since the means required to restrain it when it occurs, some time after the operation, are attended with greater danger in that part of the body than in others. In accordance with this view, we find by Table X., that 1 in every 24 cases of amputation of the thigh had been lost from this cause, whilst no death had resulted from it in the other operations. And yet, though more frequently followed by an unfortunate result, secondary hemorrhage is not a much more frequent consequence of an amputation of the thigh than of the arm or leg. According to Dr M'Hardy's researches, 1 case in 11·22 is affected by it after the thigh operation; 1 in 13·77 after the removal of the

leg; 1 in 13·5 after amputation of the arm; and 1 in 26·5 after amputation of the fore-arm.

Erysipelas seems more frequently to affect the upper extremity than the lower; thus, according to Table X., the average mortality after amputations of the arm is 1 in 13·33; whilst no deaths had been produced by it after removal of the leg, and only 1 in 97 cases of operations on the thigh. In like manner, according to Dr M'Hardy, 1 in 67·3 was attacked by erysipelas of the thigh amputations; 1 in 27·5 of the leg; and 1 in 18 after removal of the arm; whilst none out of 53 had suffered from it after the removal of the forearm.

We might have reasonably supposed, that in proportion to the extent of the body removed, we should have observed the development of internal inflammations; but such does not appear to be the case, as visceral diseases are stated to have been twice as frequent, at the Glasgow Infirmary, after removal of the leg as after that of the thigh; and the loss of the arm has exposed the patient to but little less chance of being affected by them than if he had suffered amputation *of the thigh*. Whether this may have arisen from classing together cases differing in the diseases which have required the operation, we know not; but it is not more extraordinary than the comparative freedom from phlebitis, which the most dangerous amputation is here stated to possess. Only 1 in 19·4 of the thigh amputations had perished from the latter destructive malady; whilst of those performed below the knee, the average mortality was 1 in every 3·41; and in those of the arm, 1 in 5. At the same time, as giving some support to this remarkable statement, Dr M'Hardy's statistics show 1 person in 11 affected by phlebitis after amputation of the leg; 1 in 13·5 after that of the arm; 1 in 18·36 after removal of the thigh; and 1 in 53 after amputation of the fore-arm. Altogether, these important points require further examination before we can attempt to speculate upon the probable causes which produce these varieties.

In its liability to be succeeded by diarrhœa, and by the remaining causes of death, the thigh amputation is especially remarkable.

Notwithstanding the remark which was before made, that an hospital might show the greatest mortality, and, at the same time, the shortest average period of cure after amputations, we *usually* find the longest time required for cure to coexist with the greatest amount of death. Thus, in Table VI., the mortality in cases of amputation performed for diseases and accidents below the knee, is 1 in 3·86, and the time of cure 54·9 days; whilst in those amputations performed for similar causes above it, the mortality is 1 in 4·14, and the period of cure 51·1 days. Again, in Table XI., the mortality in diseases and accidents of the thigh requiring amputation, is 1 in 1·6, and the period of cure 70·33 days; in the leg cases the mortality is 1 in 2·71, and the period of cure 60·33 days; in amputations for accidents and diseases of the arm, the mortality is 1 in 6, and the time of cure 53·33 days; and in those of the fore-arm the mor-

tality is also 1 in 6, and the time of cure 42·4 days. I have said such is usually the case, for it is not universal: thus, in the class of diseased joints and bones, whilst the mortality in amputations of the thigh was 1 in 5·44, and the time required for cure 49·34 days, in those of the leg these conditions were reversed, the mortality being 1 in 16·33, and the period of cure 52·13 days, though at the same time it should be remarked, that the time of the dismissal of the out patients in the former class of cases was 67·8 days, whilst in the latter, the out patients were dismissed from the hospital, on the average, at the 42d day. As a general rule, we may say that amputations of the upper extremity heal more quickly than those of the lower, and, in either, the time required for cure depends considerably upon the thickness of the parts at which the operation is performed.

3.—*The success of an Amputation differs according to the nature of the accident, or the disease, for which it is performed.*

It has been long observed, that a considerable difference exists in the results of amputations performed for different causes, even when the operation takes place at the same part. Some have imagined that cases of traumatic amputation are more successful, and from that have deduced the maxim, that the more robust the health of the patient, the more favourable will be the issue of the operation; whilst others again, believing the opposite to be the fact, have taught, that an individual who for some time has been suffering from a disease of the limb, will have a greater chance of recovery than another who has undergone the mutilation for an accident.

It is, however, only within the last few years that a sufficient number of hospital records have been published to enable us to settle this difference of opinion satisfactorily; and, as many still argue upon the former assumption, I have attempted to show, in the next tables, the results of experience on each side of the question.

Table XI. is formed from the registers of the Newcastle Infirmary; the other two are collected from various reports.

TABLE XI.

A view of the results of Amputations performed for accidents and diseases at the Newcastle Infirmary.

	Traumatic Amputations.						Pathological Amputations.					
	No.	Dead.	Aver. Mort.	Cure.	O. P.	Time of Death.	No.	Dead.	Aver. Mort.	Time of Cure.	Time of O. P.	Time of Death.
Diseases and injuries of thigh and knee,.....	8	5	1·6	70·33	...	6·	50	9	5·55	49·06	67·8	15·77
Diseases and injuries of leg and ankle	38	14	2·71	60·33	73·4	13·5	74	15	4·93	53·12	43·75	20·13
Amputation of shoulder joint,.....	5	2	2·5	85·66	...	1·5	...	...	...	...	...	...
Diseases and injuries of arm and elbow,.....	24	4	6·	53·33	93·	25·75	11	1	11·	41·88	...	16·
Diseases and injuries of fore-arm and wrist,	6	1	6·	42·4	...	8·	9	3	3·	42·66	...	5·66
Total,.....	81	26	3·11	56·82	79·	12·88	144	28	5·14	50·	53·	23·85

TABLE XII.

Shows the Mortality following Amputations of the lower extremity, performed for diseases and accidents, in different Hospitals.

	THIGH.						LEG.					
	Pathological.			Traumatic.			Pathological.			Traumatic.		
	No.	Dead	Aver. Mort.	No.	Dead	Aver. Mort.	No.	Dead	Aver. Mort.	No.	Dead	Aver. Mort.
Liverpool Northern Hospital,	19	1	19·	10	3	3·33	13	3	4·33	27	6	4·5
Glasgow Infirmary (Lawrie),	92	19	4·84	36	27	1·33	35	12	2·91	27	18	1·5
Chester Infirmary,	9	2	4·5	4	3	1·33	2	...	...	4	4	1·
Massachusetts and Pennsylvania Hosptls..	28	5	5·6	22	10	2·2	20	3	6·66	29	9	3·22
Hotel Dieu (Roux),	12	5	2·4	4	4	1·	9	2	4·5	3	3	1·
M. Malgaigne,	153	92	1·66	46	34	1·35	113	55	2·05	79	50	1·58
Mr Alcock, .....	...	...	...	43	27	1·59	...	...	...	11	4	2·75
Lyons Military Hospital, .....	...	...	...	4	3	1·33	...	...	...	5	3	1·66
Paris do. do., .....	...	...	...	5	1	5·	...	...	...	5	3	1·66
Royal Berks Hospital, .....	...	...	...	...	...	...	1	...	...	3	...	...
Total,	313	124	2·52	174	112	1·55	193	75	2·57	193	100	1·93

TABLE XIII.

Shows the Mortality following Amputations of the upper extremity, performed for diseases and accidents, in different Hospitals.

	SHOULDER JOINT.						ARM.						FORE ARM.					
	Pathological.			Traumatic.			Pathological.			Traumatic.			Pathological.			Traumatic.		
	No.	Dead	Av. Mort	No.	Dead	Av. Mort	No.	Dead	Av. Mort	No.	Dead	Av. Mort	No.	Dead	Av. Mort	No.	Dead	Av. Mort
Liverp. N. Hosp.,	1	...	...	1	1	1·	7	1	7·	10	3	3·33	...	...	...	7	...	...
Glasg. Infirmary,	2	1	2·	4	2	2·	17	3	5·66	36	18	2·	4	...	...	18	...	...
Royal Berks Hosp.	1	...	...	2	...	...	1	...	...	3	...	...	...	...	...	4	...	...
Chester Infirm.,...	...	...	...	...	...	...	...	...	...	2	...	...	...	...	...	...	...	...
Massachusetts and Pennsylv. Hosp.	1	...	...	1	1	1·	4	...	...	11	2	5·5	5	...	...	16	1	16·
Hotel Dieu, .....	...	...	...	...	...	...	1	...	...	2	2	1·	2	...	...	2	...	...
M. Malgaigne,	7	4	1·75	7	7	1·	61	24	2·54	30	17	1·76	17	5	3·4	11	3	3·66
Mr Alcock, .....	...	...	...	10	2	5·	...	...	...	38	19	2·	...	...	...	9	4	2·25
Lyons Milit. Hosp.	...	...	...	2	1	2·	...	...	...	7	6	1·16	...	...	...	1	...	...
Paris Milit. Hosp.,	...	...	...	2	1	2·	...	...	...	4	2	2·	...	...	...	...	...	...
Total,	12	5	2·8	29	15	1·93	91	28	3·25	133	69	1·92	28	5	5·6	68	8	8·5

Unless we altogether refuse our belief in facts, no doubt can remain upon this subject—no case can be more completely proved; with the exception of the fore arm, we find the results of the pathological amputations every where more favourable than those of the traumatic.¹ In one hospital only 1 death occurred in 19, after removal of the thigh for disease; whilst for accidents the mortality was as high as 1 in 3·33: in another, after amputation of the leg, 1 out of 4·5 perished when it was performed for pathological causes, and out of 3 amputations required for diseases all died. Again, if

¹ Although, perhaps, not strictly correct, yet, in accordance with the phraseology of other writers, I have used the terms pathological and traumatic amputations, as designating the amputations performed,—in the former case for diseases, and in the latter for accidents.

we examine the average success of all united, the same difference is apparent; thus, in amputations of the thigh for disease, 1 dies in 2·52, and after those of the leg 1 in 2·57; whilst 1 dies in 1·55 in the former operation, and 1 in 1·93 in the latter when required for accidents.

But a still more remarkable circumstance appears, viz. that, in calculating the chances for a patient, it is necessary rather to consider the cause for which the operation is performed, than the limb which is removed. Thus, although we have before proved that a vast difference exists between the results of amputations of the thigh and those of the removal of an arm, yet here we discover the mortality to be less in the former when required by disease, than in the latter when undertaken for accidents: in the one case we have a mortality of 1 in 2·52; in the other, 1 perishes out of 1·92. It is difficult of explanation why this rule is reversed in the fore arm, the mortality, both at the Newcastle Infirmary and at Paris, having been greatest in the pathological amputations: in the former hospital, 1 out of 6 died after the amputation performed for injuries, and 1 in 3 when the operation was performed for disease; and in the hospitals of Paris, Malgaigne gives the mortality for pathological amputations performed at this part at 1 in 3·4, whilst in the traumatic class it was 1 in 3·66.

In order to throw some light upon the causes from which the difference of mortality between pathological and traumatic amputations arises, the following Table has been added.

TABLE XIV.

A comparison of the Mortality observed in the Newcastle Infirmary, at different periods, after Amputations performed for accidents and diseases.

NEWCASTLE INFIRMARY.

	Within 4 Days.	4 to 7 Days	2 Wks.	3 Wks.	4 Wks.	5 Wks.	6 Wks.	7 Wks.	9 Wks.
Injuries of thigh,	2·66	...	5·	4·	...	...	...	...	...
" leg,	9·5	...	8·5	7·5	26·	25·	...	...	...
" arm, .....	...	...	...	...	8·	21·	...	...	...
Amputation of shoulder joint,	2·5	...	...	...	...	...	...	...	...
Diseases of thigh and knee,	25·	48·	23·5	...	15·	42·	...	...	...
" leg and foot,	74·	36·5	14·2	33·	64·	63·	62·	61·	60·
" arm and elbow, .....	...	...	...	11·	...	...	...	...	...
" fore arm and wrist,	9·	8·	7·	...	...	...	...	...	...

During the first four days, or, in other words, during the period of shock, the amount of death is ten times more in the thigh amputations, and eight times more in the leg amputations after an accident, than when these operations are performed for disease, and this is borne out by the statements contained in Table X. In that Table, whilst none had died of 74 from shock, exhaustion, or delirium, in the pathological amputations, 12 had perished out of 106 who had submitted to the operation for accidents, or 1 in every 8·83. Again, with respect to gangrene of the stump, which we before remarked as depending on shock, and which, we said, had usually its fatal termina-

tion during the first four days, although the average mortality had been 1 in 17·66 after amputations for injuries, no death had occurred from it amongst those previously affected with long-standing complaints.

Secondary hemorrhage, on the contrary, is most fatal after amputation for diseases, few persons undergoing an amputation for an accident being cut off by it. It will be observed, that the cases which in Table X. are stated to have died from it after traumatic amputation, were both in the class of the secondary operations, so that no person suffering a primary amputation had sunk from its effects. It is probable that this arises from the greater debility of the patients not permitting the system to rally after the loss of blood; for the occurrence of secondary hemorrhage is not much more frequent amongst amputations for diseases than for accidents. Thus, in Mr Alcock's returns, 1 case out of every 6·3 was affected with it after primary amputation; whereas in the secondary class, which may be said to be composed of persons worn down by disease, 1 out of 4·72 was attacked: but of the former class, whilst only 1 in 57 died, in the latter 1 out of 13 perished; and in four other cases of secondary amputations, the depression produced by it assisted in destroying the patient; so that, whilst in the primary amputations an unfavourable effect was produced in only 1 in 57 cases, in the secondary, either death or a very dangerous state of depression was observed in 1 in every 6·5.

Erysipelas and visceral inflammations, according to Table X., are by far more frequent in amputations for accidents than in those performed for diseases. In the pathological class none had died from the former cause, and only 1 in 24·6 from the latter; but in the traumatic operations 1 out of every 26·5 had perished from the one, and 1 of every 10·6 of the other. It will be also observed, that as both classes are pretty nearly equal in their liability to phlebitis, the chief excess of mortality, in the second and third weeks after amputations for injuries, is produced by inflammatory complaints. From this the practical rule may be deduced, that, after amputations for injuries, we should most carefully regulate the diet of the patients, confining them, in the majority of instances, to an antiphlogistic regimen for the first three weeks, at least, after the operation, and that constant care should be employed to catch the first symptoms of inflammatory disease.

After the fifth week, according to Table XIV., although no cases of traumatic amputation had been cut off at the Newcastle Infirmary, several instances of death appear to have occurred amongst those operated upon for diseases; and, on referring to the Glasgow Report at Table X., it is found that the only case of bed-sore belonged to this latter class. Another cause of death besides exhaustion is, that in some cases of pathological amputation, diseases of important viscera, as phthisis, which had previously been latent, become quickened into activity, and destroy the patient after the removal of the limb.

In the next Table, the pathological amputations are subdivided, so as to display the mortality existing in cases of amputations performed for different diseases.

TABLE XV.

Shows the success following Amputations performed at the Newcastle Infirmary for different diseases, the Amputations being classified according to the part at which the disease existed.

	Thigh and Knee.					Leg and Foot.					Arm and Elbow.					Fore Arm & Wrist.				
	No.	Av. Mort.	Cure.	O. P.	Death.	No.	Av. Mort.	Cure.	O. P.	Death.	No.	Av. Mort.	Cure.	O. P.	Death.	No.	Av. Mort.	Cure.	O. P.	Death.
Diseased joints and bones,	49	5·44	49·34	67·8	15·77	49	16·33	52·13	42·	34·66	5	...	41·4	...	...	8	4·	42·66	...	7·
Ulcers, .....	...	...	...	...	...	17	2·12	59·71	37·	10·5	...	...	...	...	...	...	...	...	...	...
Cases marked "dis-eased," .....	...	...	...	...	...	2	1·	...	...	33·5	...	...	...	...	...	1	1·	...	...	3·
Tumours, .....	...	...	...	...	...	1	1·	...	...	38·	1	...	29·	...	...	...	...	...	...	...
Gangrene, .....	...	...	...	...	...	1	...	...	61·	...	1	1·	...	...	16·	...	...	...	...	...
Diffused aneurism, ..	...	...	...	...	...	...	...	...	...	...	1	...	48·	...	...	...	...	...	...	...
Malignant disease, ..	1	...	50·	...	...	4	4·	50·33	...	9·	3	...	46·5	...	...	...	...	...	...	...

The diseases of the joints and bones are here classed together, because the nature of the affection in the latter has not been, in all cases, accurately detailed; and the majority, consisting of caries, are nearly similar to the disease of the joints usually requiring amputation. We observe how much more favourable are amputations when performed for this cause, than for other diseases; thus, in the leg cases, the mortality for ulcers is 1 in 2·12, whilst, for diseased joints and bones, it is only 1 in 16·33.

The next table shows the amount of death to be exceedingly small, in whatever hospital the records of the operation for diseased joints and bones are examined.

TABLE XVI.¹

A View of the Mortality following Amputations performed for diseases of the Joints and Bones at different Hospitals.

	Thigh.			Leg.			Arm.			Fore Arm.			Total.		
	No.	Dead	Av. Mort.	No.	Dead	Av. Mort.	No.	Dead	Av. Mort.	No.	Dead	Av. Mort.	No.	Dead	Av. Mort.
Liverpool North-ern Hospital,...	15	1	15·	9	1	9·	4	1	4·	...	...	...	28	3	9·33
Edin. Infirmary,...	13	2	6·5	7	...	...	...	...	...	...	...	...	21	3	7·
Massachus. Hos-pital, .....	...	...	...	...	...	...	...	...	...	...	...	...	20	3	6·66
University Col-lege Hospital, ..	...	...	...	...	...	...	...	...	...	...	...	...	37	5	7·4
Glasgow Infirm.,...	24	6	4·	9	2	4·5	8	...	...	3	...	...	131	23	5·69
Hotel Dieu,	12	5	2·4	9	2	4·5	1	...	...	2	...	...	24	7	3·42
Newcastle Infirm.	49	9	5·44	49	3	16·33	5	...	...	8	2	4·	111	14	7·92
Total, .	113	23	4·91	83	8	10·37	18	1	18·	13	2	6·5	372	58	6·41

¹ The total number of amputations at the Glasgow Infirmary, consists of the whole of the diseased joints and bones as given by Dr Lawrie. Those placed under the heads of thigh, leg, &c., are composed of a few of the diseased joints alone.

How strikingly different are the conclusions which must be drawn with respect to the event of amputations, when thus classified, from those arising from the inspection of the mortality of the most successful general division; viz., that of amputation for pathological causes! The surgeon, looking only at the number of deaths compared with the amount of cures in a general summary of the results of all amputations, must feel inclined, with a late author, to "raise a question as to the value of operations at all;" whilst, when he learns that seventeen out of eighteen of the individuals whose arms have been removed for diseased joints have been thereby saved from certain death, he views operative surgery in its proper light, as one of the greatest blessings which have resulted from the exercise of human skill.

In the case of the thigh, for whatever cause we amputate it, a considerable number of the cases seems to perish; but this mortality greatly diminishes as the amount of body we remove is lessened:—thus, whilst of amputations performed above the knee for diseased joints, 1 person out of 5 appears to have died; below that point, only 1 in 10 has perished.

The small number of deaths, after amputation of the arm, is worthy of remark, on account of the value of amputation as compared with resection of the elbow joint.

Now, although no deaths have occurred of five amputations of the arm at the Newcastle Infirmary, yet of nine cases of resection of the elbow for disease, three have died, or 1 in 3. Of the six cured, I have been able to trace two who, within two years after the operation, died of phthisis. The average period of cure in the amputation of the arm, at this same infirmary, was 41·4 days; whilst that in those who submitted to resection, was 59·5 days; and the average time of dismissal of those who left the hospital as out-patients, with their wounds still unhealed, was 121 days. In deciding, therefore, upon the nature of the operation we will perform upon a diseased elbow, the surgeon must carefully consider, whether the amount of bone requiring removal will afford a sufficient chance of a useful arm to compensate his patient for the greater hazard to life incurred by submitting to resection.¹

It is, however, somewhat remarkable, that the amount of death should be greater after amputations of the fore arm than after those of the arm, when in traumatic amputations it is so much less. The increase of death is caused by two cases reported from the Newcastle Infirmary; both were operated upon in unhealthy weather, and on the same day, and both, I believe, died from erysipelas—one on the fifth, and the other on the ninth day after the operation. No death is recorded in any of the other hospitals.

¹ It must be remembered, that this mortality of the operation of resection, is only the result observed at the Newcastle Infirmary. Surgeons of other institutions have, I believe, been more successful; but I have not, as yet, collected the returns of their practice.

I have not been able to obtain a sufficient number of the post-mortem examinations of cases dying after amputation for diseased joints and bones, to throw any light upon the nature of the diseases to which this class of operations is most liable, but have added a calculation of the comparative danger of the different classes of pathological amputations, in each week after the operation, as observed at the Newcastle Infirmary.

TABLE XVII.

Shows the Mortality observed at the Newcastle Infirmary within certain periods after Amputation performed for different Diseases.

Newcastle Infirmary.	1 to 4 days.	4 to 7 days.	2d week.	3d week.	4th week.	5th week.	6th week.	7th week.	9th week.
Diseased Joints } and Bones, ... }	55·5	54·5	26·75	0 in 103	34·33	50·	...	...	98·
Ulcers,	17·	8.	4·6	5·5	...	...	...	...	...
Other Diseases,...	16·	0 in 15	15·	14·	13·	...	12·	11·	...

Compared with the vast mortality after amputations for accidents, the chance of death, after an amputation for a diseased joint, seems to be, in the first four days, scarcely worthy of notice ; not two deaths in 100 amputations [taking place during the period of shock. The danger seems pretty equal in the first and second weeks, after which time, we may imagine, from the absence of mortality in the following period, that the danger from inflammatory complaints is trifling. In the fourth and fifth weeks, it may be reasonably supposed that the usual cause of death has been exhaustion, to which we before found persons suffering amputations more liable when the operation was performed for pathological than for traumatic causes.

TABLE XVIII.

A comparison of the Mortality at different Hospitals following Amputations performed for various diseases.

	Massachu- setts Hospital.		Liverpool Northern Hospital.		Glasgow Infirmary.		University College Hospital.		Edinburgh Infirmary.		Newcastle Infirmary.		Total.		
	No.	Av. Mort.	No.	Av. Mort.	No.	Av. Mort.	No.	Av. Mort.	No.	Av. Mort.	No.	Av. Mort.	No.	Dead	Av. Mort.
Ulcers,	15	15·	...	...	5	1·25	...	...	...	...	17	2·12	37	13	2·84
Diseased soft Parts,	3	3·	...	...	...	...	9	9·	...	...	3	1·	15	5	3·
Tumours,	2	2·	...	...	12	4·	...	...	...	...	2	2·	16	5	3·2
Gangrene,	4	...	8	4·	5	2·5	...	...	1	1·	2	2·	20	6	3·33
Aneurism, .....	...	...	2	...	...	...	...	...	1	1·	1	...	4	1	4·
Deformities,	1	...	2	...	...	...	...	...	...	...	...	...	3	...	...
Amputation of } Stumps, .....	...	...	...	...	...	...	4	...	2	...	1	...	7	...	...
Malignant Diseases,	2	...	...	...	...	...	...	...	...	...	8	8·	10	1	10·

The removal of a stump appears to be attended with less danger

than an amputation even for a diseased joint, and perhaps the explanation of the fact is pretty apparent. In the second amputation, although the patient be sufficiently reduced by the suffering for which he submits to the operation, he is seldom so much exhausted by hectic as to excite any fears of his perishing from shock; in addition to which, having before undergone the trial, he is not so much depressed by the fear of a fatal result. The system has also become accustomed to the loss of a portion of the body, and the fact of the patient's having before recovered, is a good indication that no latent disease exists which might produce death at a late period after the amputation.

The operations for malignant diseases seem, at first sight, peculiarly successful; but, on referring to Table XV., this is easily explained. It will be there seen, that at the Newcastle Infirmary one in four died of those who suffered amputation of the leg for malignant diseases; whilst, in the class of diseased joints, only one case of leg amputation perished out of 16·33, and the numbers of the operations on the arm and thigh for malignant disease are too small to expect any mortality. The greater number of the amputations of the leg in this class of malignant diseases, at this infirmary, were performed for fungoid diseases of the bones, a complaint which does not seem to have the same tendency to be reproduced as tumours of a similar appearance when existing in the other structures of the body. In the fatal case only was any enlargement of the glands of the groin remarked. The disease in the thigh case consisted also of a fungoid tumour connected with the bone. In the arm, two cases were cancerous ulcers, and one was a fungoid tumour.

The mortality, after amputations performed for deformities, is probably regulated by the same general rule that we apply in our consideration of the hazard of removing a limb for a tumour, which may obstruct the motions of the limb, as in both the patient is usually in the enjoyment of good health. If in such cases the patient be much reduced by pain or other causes, his chance of recovery will be allied to that of those affected with a diseased joint; whereas, if his only complaint be the inconvenience arising from the disease, and his condition of body be robust, his hazard will be much greater. Only three cases of amputation for deformity are given in Table XVIII., and none terminated fatally, although I have seen persons who have been relieved of their limbs for this cause by over-zealous operators, who have forfeited their lives to the experiment. Indeed, no surgeon can be justified in removing a limb for deformity alone, even at the most earnest request of his patient, unless he first explain to him the danger he will incur by the operation; and, if the surgeon agree to undertake it, the most careful preparation should be used, as, taking together the numbers of the two classes just quoted—viz., those of amputations for tumours and deformities—we have five fatal cases out of nineteen operations, or 1 in every 3·8.

Of the four cases of aneurism in Table XVIII., three were ampu-

tations of the thigh, of which two were performed for diffuse femoral aneurism, and both recovered; the other died from phlebitis after the operation, which was required on account of hemorrhage from a popliteal aneurism. The fourth case was an amputation of the arm, performed on account of hemorrhage occurring after a ligature had been placed on the brachial artery, which had been previously wounded in venesection.

Along with the cases of gangrene have been included four amputations for frost-bite, performed in the Massachusetts hospital; but as this class contains all descriptions of mortification, but few practical conclusions can be derived from its results. In one case, in the Newcastle Infirmary, where the leg was removed below the knee for gangrena senilis, the disease reappeared in the stump, upon which amputation was again resorted to, and the patient, notwithstanding that he was at an advanced period of life, eventually recovered.

The most unsuccessful of all the pathological amputations are those in which ulcerations form the prominent feature. If we exclude the cases mentioned in the report of the Massachusetts hospital, of the nature of which I am ignorant, we find twelve deaths in twenty-two amputations, or 1 in every 1.83. It is from the great mortality so generally remarked as following amputations performed for ulcerations, that some have recommended union by granulation after such operations; they supposing that death usually results from the sudden stoppage of a discharge to which the system had been habituated.

It appears to me, that in the consideration whether it is better to attempt the cure of amputations, performed for cases in which a long-continued discharge has existed, by means of adhesion or granulation, two questions are involved. The first of these is, Does the stoppage of a long-continued discharge, under all circumstances, prove injurious? and, 2dly, If such be the case, what is the best method of preventing danger?

Now, in proof that the stoppage of a discharge is apt to produce danger, we may refer to the great mortality following amputations for ulcerations, when compared with that consequent on the same operation performed for other diseases. Besides which, it is frequently seen in hospitals, that an individual, shortly after being cured of an ulceration, is attacked by some other disease, the symptoms of which, although the complaint before existed, had not previously appeared. A case, strikingly illustrative of this, occurred a few years ago at the Newcastle Infirmary. A thin spare man, of intemperate habits, had been for many years troubled with chronic ulcers of the legs. His health, in other respects, appeared excellent; but the sores resisted every means tried to heal them. For many years he frequented the hospital, and every surgeon connected with the institution had treated him ineffectually. At last the sores

commenced healing, and in a few weeks he was quite well. He had only been dismissed for a fortnight, when he again presented himself, labouring under a new set of symptoms. General dropsy had appeared, and he died in a few weeks. On a post-mortem examination, the heart was found vastly enlarged; and yet, during the many years that this disease must have existed, he had never complained of the slightest inconvenience from it, until the discharge from the legs had been stopped. Again, Mr Phillips has informed us, that in Great Britain, of 60 cases of different diseases in which ulcerations existed, and in which immediate union took place after amputation, 15 died—or 1 in 4; whilst of 26 instances of union by granulation, only 5 deaths occurred—or 1 in 5·2; and of 57 persons in whom, in other countries, the former plan had been tried, 14 perished—or 1 in 4·07; whilst of 70 whose wounds had united by granulation, only 15 died—or 1 in every 4·6.

On the other hand, we seldom amputate a diseased joint unless the complaint be of considerable duration, and the system has been, therefore, for some time accustomed to discharge; and yet so little danger has resulted from the ordinary method of dressing the stump, that only 1 death has resulted of 18 amputations, performed in different hospitals, for diseased elbow. Again, how constantly do we observe leucorrhœa and dysentery stopped within a few weeks without the slightest injury, and even with considerable benefit to the general health.

How, then, are we to reconcile these adverse facts? By attending to the state of the constitution of the patient. Thus, it is a matter of daily observation, that if, in an individual of otherwise healthy constitution, we remove a limb, which, by its disease, has long worn down his strength, an immediate improvement is the result; but if, on the contrary, the same amputation be performed on another, in whose lungs tubercles are existing, the wound of the knife will be scarcely healed before symptoms of the fatal disease manifest themselves in full force. Now, with respect to cases of ulcers, not only are the greater number of persons requiring the amputation at an unfavourable age; but, in general, the same state of constitution which has necessitated the operation, acts also in producing dangerous consequences after its performance. Few long-standing and extensive ulcerations exist, without their being either dependent on visceral disease, or coexistent with a constitution broken up by syphilis or intemperance; and it should be also remembered, that in by far the greater number the veins of the limb are so thickened and diseased, that they will afford an increased chance of the introduction of purulent matter into the circulation. With respect to Mr Phillips' calculations, it can scarcely be supposed that such a general comparison can be of much service in settling a point of this nature; for where no classification is attempted of the parts at which the operation was performed, and where neither the ages of the patients, nor the precise nature of the disease requiring the removal

of the limb, is taken in consideration, it is evident that very erroneous conclusions might be drawn.

If, then, the stoppage of a discharge be only injurious in unhealthy constitutions, it is evident that, where the complaint is plainly of a local nature alone, as is usually the case with a disease of the joint, it would be folly, by preventing all adhesion, to protract the cure after the removal of the limb. But where we are obliged to amputate in cases in which a long-continued discharge is, to a certain extent, a beneficial action, or where the constitution is obviously unhealthy, it will be well to guard against the sudden removal of that discharge after amputation.

With respect to the second question, authors have recommended two plans,—union by granulation, and the insertion of an issue. It appears to me, that if the continuance of a discharge be alone required, the latter of these will most fully accomplish the object. For, whilst the open state of the wound of an amputation must keep up the liability to phlebitis, the discharge will be less under control than when coming from an issue.

But as to the method of amputating which is the best to be employed, whilst my own experience has taught me to concur with the observation of a military author, that surgeons, in general, are too anxious to glue up an amputation wound by the first intention, I believe that complete union by adhesion should be especially avoided when the operation is performed in cases in which chronic ulcerations exist, as the patent condition of the varicose veins, which usually accompanies such disease, must give an increased chance of any pent up pus being introduced into the circulation. In amputations, then, for chronic ulcers, in which there is either a suspicion of latent disease, or where the veins of the limb are varicose, in addition to the employment of the circular method, it would, perhaps, be advisable to introduce a strip of lint between the edges of the wound, so as to prevent immediate adhesion, and thus allow free exit to any discharge which might be secreted.

4.—*The Success of an Amputation is influenced by the duration of the disease for which it is performed.*

The maxim has been laid down by an eminent surgical authority, that, in amputations for diseased joints, “the shorter the duration of the disease, and the less the system has suffered under it, the greater is the chance of recovery after amputations, and *vice versâ*.” As no facts of any importance are brought forward to verify this assertion, I considered its correctness well worthy of investigation. It would, indeed, seem probable, that if a person labouring under a disease of a scrofulous nature, have less tendency to secondary diseases after an amputation, than an individual in robust health, and the more the strength of a patient be reduced, the less will be his risk from these causes of death, and the only increase of danger he will be exposed

to by his debility, will arise from exhaustion. But as in a former table we found that, in practice, but a small proportion died from shock or subsequent weakness, we might, from theory, reasonably feel inclined to call in question the truth of the assertion I have before quoted.

The next table is formed of amputations performed for diseased knee and ankle joints at the Newcastle Infirmary, classified according to the number of years they had existed previous to the operation. Under the head of total, we have the mortality, both inclusive and exclusive of those who died within the first four days after submitting to the amputation.

TABLE XIX.

A view of the Mortality at the Newcastle Infirmary following Amputations performed for Diseased Joints, at different periods of time after the commencement of the disease.

	Knee.			Foot and Ankle.			Total.					
							Including deaths in first four days.			Exclusive of deaths in first four days.		
	No.	Dead	Av. Mort.	No.	Dead	Av. Mort.	No.	Dead	Av. Mort.	No.	Dead	Av. Mort.
One Year,.....	13	4	3·25	11	1	11·	24	5	4·8	23	4	5·75
Two Years,.....	8	...	...	9	...	...	17	...	...	17	...	...
Three "	2	1	2·	3	...	...	5	1	5·	4	...	...
Four "	2	...	...	4	...	...	6	...	...	6	...	...
Five " .....	...	...	...	1	1	1·	1	1	1·	1	1	1·
Above Five Years,.....	9	3	3·	6	...	...	15	3	5·	15	3	5·

Instead of the mortality being less in those cases of amputation in which the disease was of only one year's duration, it is greater in them than in those of any subsequent class. Rejecting the deaths occurring during the first four days as probably produced by shock, we find that 1 in 5·75 died after that period in those whose disease had existed 1 year, whilst amongst those who had been affected between 1 and 4 years, none perished out of 27. Those who had suffered from disease for more than 5 years have been classed together, on the supposition that, as in some the complaint had existed for a very long period, the health would probably be but little affected, and that they had required the removal of the limb, rather on account of its inconvenience or deformity, than for the preservation of life. But as we before observed, that the greater number of deaths of persons submitting to amputation, and occurring after the period of shock, was produced by inflammatory or suppurative diseases, it is evident from this table that such patients as have laboured under diseased joints between 1 and 5 years, are less liable to be attacked by those complaints after the operation, than others who have been affected either within 1 year, or for a greater length of time than 5 years. If these results should be confirmed by other observations, the information to be derived from them will be exceedingly valuable ; for it will appear that the impatience of

the surgeon will be more generally to be dreaded, than danger from delay. I have seen more than one individual obtain a useful joint, where excellent surgeons had urged the necessity of amputation, and declared recovery without it as impossible; and I have on more than one occasion dissected joints, in which the knife of the operator had interfered, whilst nature was safely accomplishing ankylosis. The number of amputations performed for this class of diseases is every year decreasing as more simple and effectual methods of treatment are employed; and we have good reason to hope that, in a few years, the removal of a limb for a diseased joint will be as rare as it was formerly common.

Dr Lawrie has proved that the success of his predecessors at the Glasgow Infirmary has been greater than his own, and a greater amount of cures is also observable in the Newcastle Infirmary records, as having occurred a few years ago than can be boasted of at the present time. Thus, in the years beteen 1823 and 1834, omitting 1829 and 1831, in which the operations were not regularly recorded, there were 21 amputations for diseased knee, of which 2 died, or 1 in 10·5; and 22 for diseased foot and ankle, of which only 1 died; whilst, in the time from 1833 to 1842, there were 18 of the former operations and 3 deaths, or 1 in 6, and 16 of the latter amputations, and 2 deaths, or 1 in 8; and, even if we add the operations performed in the two years, in which all have not been recorded, we find in the former period 51 amputations of the lower extremities of which 6 died, or 1 in every 8·5, whilst in the latter there are 34 amputations and 5 deaths, or 1 death in every 6·8 operations. It is difficult to advance a satisfactory reason for this increase in mortality; but the most probable supposition seems to be, that it may have arisen partly from the greater number of persons received into the hospital; for, by the Newcastle Infirmary annual reports, it appears that during the former more successful period only 7267 in-patients were dismissed cured, whilst the number in the subsequent and more fatal years was 9749.

The time required for recovery after the operation seems to have a certain relation to the amount of death; thus, in those in whom the disease had existed only for 1 year, the time of cure was 56 days; in amputations performed upon those who had suffered between 1 and 2 years, it was 44·6 days; in those the duration of whose disease was between 2 and 5 years, it amounted to 38 days; and of those who had been invalids above 5 years, it required 53·5 days to complete the cure.

From the above facts the natural conclusion appears to be, that so long as the life of the patient is not placed in immediate danger by his disease, we shall best consult his interest by deferring the operation, since, besides giving him a greater chance of a natural recovery, the amputation will be more successful, and less time will be required to heal the wound in case it be eventually required.

Of 9 cases of amputation for ulceration of the leg, in 3 the disease had existed 2 years or less, and all recovered ; 3 had suffered between 2 and 3 years, and 1 died ; whilst of 3 who had been affected for 10 years or upwards, only 1 recovered after submitting to the operation. The period required for cure in the first class was 55·2 days ; whilst of those whose complaint has existed above 2 years, the time of cure was 67·66 days.

There have been few points in operative surgery more fiercely discussed, than the proper time for amputation after the infliction of an injury. For a considerable period, the main argument used by both parties, was the comparative chance of death in traumatic and pathological amputations. This point we have before examined, and indeed, as it is easily seen, it is one which should be allowed to have but little weight in forming our opinion. Both parties have latterly appealed to the results of practice, and in the following tables all the statements I have been able to collect upon this point are produced :—

TABLE XX.

A comparison of the success following Primary and Secondary Amputations performed at the Newcastle Infirmary.

TRAUMATIC AMPUTATIONS.

	Primary.					Secondary.				
	No.	Dead	Av. Mort.	Cure.	Death.	No.	Dead	Av. Mort.	Cure.	Death.
NEWCASTLE INFIRMARY.										
Injuries of Thigh,.....	8	5	1·6	70·33	6·	...	...	...	...	...
" Leg,.....	31	12	2·58	66·27	14·16	7	2	3·5	45·25	10·5
" Arm,.....	23	4	5·75	53·33	25·75	1	...	...	..	...
" Fore-arm,.....	6	1	6·	42·4	8·	...	...	...	...	...
Amputation of Shoulder Joint,.....	3	1	3·	72·	2·	2	1	2·	113·	1·
Total,.....	71	23	3·08			10	3	3·33		

TABLE XXI.

Shows the results of Primary and Secondary Amputations performed at various Hospitals.

	Thigh.				Leg.				Shoulder Joint.				Arm.				Fore-arm.			
	Prima.		Second.		Prima.		Second.		Prima.		Second.		Prima.		Second.		Prima.		Second.	
	§	Av.	§	Av.	§	Av.	§	Av.	§	Av.	§	Av.	§	Av.	§	Av.	§	Av.	§	Av.
	№	Mort	№	Mort	№	Mort	№	Mort	№	Mort	№	Mort	№	Mort	№	Mort	№	Mort	№	Mort
Liverpool Northern } Hospital, }	7	7·	3	1·5	21	5·25	6	3·	1	1·	...	...	6	3·	4	4·	7	...	...	...
Edinburgh Infirmary, ...	7	1·	...	...	2	1·	...	...	1	...	...	...	...	...	...	...	...	...	...	...
Glasgow Infirmary,	12	1·09	24	1·5	22	1·46	5	1·66	3	1·5	1	...	23	2·09	13	1·85	15	...	3	...
Glasgow Infirmary,	11	3·66	...	...	16	4·	...	...	4	4·	...	...	10	5·	...	...	5	...	...	...
Chester Infirmary,	2	2·	2	1·	3	1·	1	1·	...	...	...	...	1	...	1	...	...	...	...	...
Massachusetts and } Pennsylvanian Hosp. }	12	1·71	10	3·33	14	14·	15	1·87	1	1·	...	...	6	3·	5	...	10	...	6	6·
Mr Alcock,	19	1·46	24	1·71	4	2·	7	3·5	9	9·	1	1·	21	1·75	17	2·42	4	2·	5	2·5
University College } Hospital, }	2	2·	...	...	4	2·	...	...	...	...	...	...	...	...	...	...	2	...	...	...
Total,	72	1·63	63	1·7	86	2·6	34	2·12	19	3·16	2	2·	67	2·31	40	2·66	43	21·5	14	4·66

TABLE XXII.

Mr Alcock's Table of the results of Primary and Secondary Amputations in Military practice.

	Primary.			Secondary.		
	No.	Dead.	Av. Mort.	No.	Dead.	Av. Mort.
Baron Percy at Newbourg,	92	6	15·3	...	...	...
Baron Larrey,	14	2	7·	...	...	...
New Orleans,	45	7	6·42	7	5	1·4
Naval Action of June 1, 1794,	60	8	7·5	...	...	...
Battle of Aboukir,	11	...	...	3	3	1·
Battle of Camperdown, } Upper extremity,	7	...	...	...	...	...
Dr Wright—Flag Ship } Lower Do.....	8	...	...	...	...	...
Venerable,						
Bombardment of } Upper extremity,	28	7	4·	2	2	1·
Algiers,	29	15	1·9	...	...	...
British Peninsular Army } Upper extrem..	163	5	32·6	296	116	2·5
in six months,	128	19	6·7	255	149	1·7
Thoulouse—Mr Guthrie's } Upper extrem.	7	1	7·	16	4	4·
Report,	41	9	4·5	37	18	2·
Navarino—M. Signore,	31	1	31·	38	13	2·8
Total	664	80	8·3	654	310	2·1

At the Newcastle Infirmary, the secondary amputations, where, as in injuries of the leg, we have the means of comparison, appear more favourable than those performed immediately after the occurrence of the accident. It is also worthy of observation, that the time required for the healing of the wound is considerably less in the former than in the latter; thereby confirming the truth of the rule, that the period of cure is less in a person submitting to the removal of a limb for disease, than when the operation is performed upon an individual in perfect health.

The difference in the results furnished by tables 21 and 22 is particularly striking. In the latter table the primary amputations

are exceedingly successful, the average mortality being 1 death in every 8·3 amputations; whilst, in those performed at a subsequent period, 1 death has taken place out of every 2 cases. Or, again, if we look at the statement of the mortality after amputations of the upper extremity, as given in table 22, and which were performed in the British army, we find 1 out of 2·5 died of the secondary, and only 1 of 32·6 of the primary class of operations. But on the other hand, the records of civil practice place the matter in a different light. Here, in some hospitals, as in the Glasgow and Newcastle Infirmaries, the advantage is with the delayed operations; and even taking the general average mortality of the whole of the hospitals, the difference of mortality after amputations of the thigh and arm, between the primary and secondary amputations, is so slight as to be scarcely worthy of notice.

It has always appeared to me, that the mere knowledge of the amount of death following primary and secondary amputations, is not of much importance in enabling us accurately to determine the question of their comparative value. The original point of dispute appears to have been, whether the surgeon would save most lives by amputating a limb immediately after the infliction of an injury, or by deferring the operation to a future period. If, then, we imagine amputation deferred in twenty cases of serious accidents, in which the powers of nature are obviously unable to repair the injury, the question to be decided must be, not so much as to the mortality which will occur amongst those on whom the secondary operation is performed, as the number of the patients who will reach that state in which the limb can be removed. For if a person suffer a compound fracture, or other severe injury, he becomes liable to attacks of phlebitis and visceral diseases, in the same manner as if he had undergone amputation. Some have supposed, that by obtaining the number of deaths which have resulted amongst any number of compound fractures treated without amputation, we might calculate the proportion which would perish out of an equal number of cases deferred for secondary amputation. But it will be observed that, as the cases of compound fracture treated without amputation are selected as likely to terminate well, they can afford us no guide as to the mortality which is likely to occur from diseases amongst accidents of a more severe character.

From the great danger to which every day's experience teaches us, severe accidents are liable before secondary amputation can be undertaken, the conclusion is manifest, that we cannot be justified in deferring the operation, where the powers of nature will be evidently unable to repair the injury. But, on the other hand, the mortality after primary amputations likewise warns us against being, in the first instance, too solicitous to remove a limb, whose injury it is possible nature might repair, under the supposition, that in so doing we place our patient in a state of comparative safety.

We have before seen that different diseases appear at different

periods after the performance of an amputation, and that the occurrence of inflammatory complaints is chiefly to be dreaded in persons whose strength has not been reduced by long-continued disease. Experience also teaches us, that during the first three weeks after the infliction of a severe injury, as a compound fracture of the leg, the same disposition to visceral and inflammatory diseases is manifested, and that the amputations which are performed during that period are exceedingly unsuccessful. After, however, the suppurative stage has commenced, amputation may be resorted to, with a chance of success approaching that of the operation when performed for a long standing disease.

In order to show the difference in mortality following amputations performed at these different periods after an accident, I have added Table XXIII., which is extracted from Mr Alcock's valuable lectures on amputation.

TABLE XXIII.

Shows the difference in Mortality between Intermediary and Secondary Amputations.

	Thigh.			Leg.			Arm.			Fore Arm.		
	No.	Dead	Av. Mort.	No.	Dead	Av. Mort.	No.	Dead	Av. Mort.	No.	Dead	Av. Mort.
INTERMEDIARY.												
Mr Alcock,.....	9	6	1.5	4	2	2.	11	6	1.83	3	2	1.5
Mass. and Penns. Hosp.	4	3	1.33	7	4	1.75	...	...	...	...	...	...
Total,.....	13	9	1.44	11	6	1.83	11	6	1.83	3	2	1.5
SECONDARY.												
Mr Alcock,.....	15	8	1.87	3	...	...	6	1	6.	2	...	...
Mass and Penns. Hosp...	6	...	...	8	4	2.	5	...	...	6	1	6.
Total,.....	21	8	2.62	11	4	2.75	11	1	11.	8	1	8.

The difference in mortality is here very striking, and shows most distinctly the greater chance of recovery of a patient after an amputation performed during the suppurative stage. We here find a ready explanation of the discrepancies of various authors, with respect to the amount of death after the delayed operation; for where a surgeon makes it a practice only to amputate in the secondary period, that is, after the 21st day, his success is certain to be vastly greater than another, who attempts to save his patients by having recourse to the operation in the intermediary period, when inflammatory complaints are so apt to occur:—the former may be able to boast of only 1 death in 6 of those in whom he removes the arm, whilst the latter may be compelled to allow an average mortality of 1 in 1.83 after the performance of the same operation.

It is likewise remarkable how slight is the difference in the intermediary period between the mortality after amputations of the thigh, and that occurring after those of the arm; whereas in the secondary

period the difference is very observable; showing that in the former the danger from any operation is so great, that the amount of a limb removed has but comparatively little effect upon the result. The obvious conclusion from such a fact is, that we should avoid the performance of any operation upon a compound fracture during the first three weeks after an accident, providing it can be safely deferred until the suppurative stage has commenced. Table X. shows us the most frequent causes of death after the primary and secondary operations. It is there seen, that whilst in the former the chance of fatal shock, exhaustion, and secondary hemorrhage is less, the liability to secondary inflammations, as phlebitis and erysipelas, is considerably greater. In visceral inflammations, the danger from both is, however, nearly equal, which most probably arises from the operations performed during the intermediary being classed along with those which took place in the secondary period. Gangrene produces death, as might be expected, more frequently in the primary operations.

Mr Alcock has given us the following account of the causes of death, of amputations performed in his own practice, classified according to the period at which the operations took place. In the primary amputations, the average mortality from shock was 1 in 57; in the intermediary period, none died of 27 cases; whilst of the cases of amputation performed after the twentieth day, 1 out of every 8.66 sank from exhaustion or shock. Thus, of all the classes of amputation which we have hitherto examined, that consisting of the operations performed after the twentieth day after the receipt of a severe injury, incurs most risk from shock; and herein is the character which most distinguishes the mortality following secondary amputations, from that observed after amputations for long standing diseases.

Again, whilst, in Mr Alcock's practice, in the primary amputations 1 case in every 9.5 was affected with phlebitis, and 1 in every 3.56 with visceral inflammations or abscesses, and whilst of the intermediary operations 1 in 9 suffered from the former, and 1 in 5.4 from the latter diseases, no death occurred amongst 26 secondary operations from these causes.

On the other hand, according to the same author, 1 in every 6.5 amongst the secondary amputations perished from hectic or exhaustion following some time after the operation, whilst none amongst either the primary or intermediary classes sank from these affections.

These facts most strikingly confirm the view formerly given, with respect to the necessity of antiphlogistic treatment after primary amputations, and show us that the more the patient is reduced previous to the operation, the less danger is there of his becoming affected by those serious secondary inflammations which cause so much of the mortality observed after the performance of this operation on healthy individuals.

But a question has been raised with respect to the time after an accident at which it is proper to perform a primary amputation; whether the limb should be removed whilst the patient is in a state of depression, or the operation be delayed until reaction take place. Common sense, as well as the results of experience, decides the matter at once in favour of the latter plan; and I have seen, I believe, many deaths occur after amputations, from the shock of the operation being inflicted whilst the patient was suffering from that of the accident. Table XIV. shows us that the chief mortality within the first four days after amputations for accidents, is in the thigh operation; it is, therefore, necessary to remember, that in all amputations at this part, on account of the operation itself inflicting a greater shock on the system than when performed elsewhere, a larger interval of time should be allowed to elapse between the receipt of the accident and the application of the knife.

5.—*The Success of an Amputation is influenced by the method by which it is performed.*

There is perhaps no dispute with respect to amputations, in which we find so many theoretical arguments, and so few facts—such sweeping conclusions, and such a paucity of experience brought forward to justify them—as in the controversy regarding the flap and circular operations. I would not, indeed, have thought it worth while to make the following remarks, on account of the few facts I can bring forward, had it not been that the authors of some of our most recent and best works on operative surgery, have written on the question as though it were already settled, and as though the flap operation were so much superior to the more ancient method, that it was almost needless to describe any other. It is not, unfortunately, recorded in the register of the operations performed at the Newcastle Infirmary, in which case the flap and in which the circular method was employed; but I have been able to form an approximate estimate of the comparative success following the employment of each, by separating the operations of each surgeon. For a long series of years, the late Mr Baird was the only operator who employed the flap method, which, as far as my recollection extends, he did on all occasions in the lower extremity, always, however, removing the upper by the circular operation. We have, therefore, to compare the results of his practice with the success of his colleagues.

TABLE XXIV.

A Statement of the comparative success following the Flap and Circular methods of performing Amputations of the Lower Extremity at the Newcastle Infirmary.

	Thigh and Knee,					Leg and Ankle,				
	No.	Dead	Av. Mort.	Cure.	Death.	No.	Dead	Av. Mort.	Cure.	Death.
DISEASED JOINTS & BONES.										
Mr Baird—Flap.....	10	3	3·33	45·7	9·60	9	1	9·	54·16	60·
Other Surgeons—Circular	39	6	6·5	49·85	18·83	40	2	20·	51·67	47·5
TRAUMATIC AMPUTATIONS.										
Mr Baird—Flap.....	1	1	1·	...	2·	8	3	2·66	76·33	5·66
Other Surgeons—Circular	7	4	1·75	70·33	7·	30	11	2·72	57·75	16·66
OTHER PATHOLOGICAL AMPUTATIONS.										
Mr Baird—Flap.....	...	...	...	...	...	6	1	6·	46·6	8·
Other Surgeons—Circular	1	...	...	50·	...	19	11	1·72	61·28	17·27

This table displays a rate of mortality very different from what I expected to have found before I collected the facts from which it is compiled. In every instance, except after amputations performed for ulcers and malignant diseases, the advantage is on the side of the circular; and this is the more extraordinary, since, from the year at which this report closes, the other surgeons of the hospital have chiefly practised the flap operation, which is, in fact, now as generally used as the other was a few years back. It is, however, but just to observe, that the practice of Mr Baird may not give us a fair means of comparison, as he frequently undertook operations which more cautious surgeons might perhaps have declined; and although, by his boldness, I have seen cases rescued from the grave, yet the greater number of dangerous amputations he performed, may in some degree have contributed to cause the excess of deaths above observed. In the same way, perhaps, we may account for the lengthened time of cure; for I never saw, in the practice of any other individual, so many stumps heal by the first intention.

The conclusions which we might be inclined to draw from Table XXIV. are to a certain extent borne out by the following table :—

TABLE XXV.

A comparison of the Mortality observed after Flap and Circular Amputations by the two under-mentioned Authors.

	Circular.			Flap.		
	No.	Dead.	Aver. Mort.	No.	Dead.	Av. Mort.
THIGH.						
Dr M'Hardy,	100	28	3·57	102	28	3·64
Mr Alcock,	32	20	1·6	11	7	1·57
LEG.						
Dr M'Hardy,	43	7	6·14	12	4	3·
Mr Alcock,	9	3	3·	2	1	2·
ARM.						
Dr M'Hardy,	30	9	3·33	24	5	4·8
Mr Alcock,	34	16	2·1	4	3	1·33
FORE ARM.						
Dr M'Hardy,	26	2	13·	27	...	...
Mr Alcock,	7	3	2·3	2	1	2·

Merely looking at the mortality, as thus stated, we find that the success of each method of amputation is about equal in the operations of the thigh and arm; or, at any rate, the advantage which in either case is gained in the statistics of the one author, is lost by those of the other. In the leg amputations, both reports agree in favour of the circular; a considerable excess of mortality being observable when the flap operation has been employed. In the fore-arm, on the contrary, the latter method has been most successful; for although, in Mr Alcock's account of his practice, the average mortality is rather smaller, it is not so much so as to balance the greater number of deaths following the circular operation, as given in Dr M'Hardy's statements.

It has been before seen, that phlebitis and purulent deposits constituted by far the most fatal class of diseases occurring after amputation; the comparison, therefore, of the liability of a number of persons to these affections, after submitting to the different methods of operation, is highly important. Dr M'Hardy, out of 165 flap amputations, gives 12 cases of phlebitis as having occurred, or 1 in 13·75; whilst, of 199 circular, only 9 were affected with it, or 1 in every 22·11. Again, Mr Alcock states, that out of 87 circular operations, 10 died of phlebitis, or purulent deposits, or 1 in every 8·7; whilst, of 24 flap operations, 6 perished, or 1 in every 4, from the same class of diseases. Taking, then, the general amount of death as caused by these diseases, the advantage is vastly in favour of the circular operation; or, if we confine our attention only to the primary amputations, Mr Alcock informs us, that of this class, after the circular operation, 1 in 6·5 died of phlebitis, or purulent deposits; whilst, after the flap amputations, 1 in 3 died of phlebitis, or purulent deposits. If we investigate the frequency of their occurrence, with respect to the site at which the amputation is performed, we find a somewhat different statement. According to Dr M'Hardy,

1 in 24 was attacked by phlebitis when the arm was removed by the flap, and none out of 27 cases of the fore-arm amputation when the flap method was employed; whilst, after the circular operation, 1 case of phlebitis took place in every 10 when it was performed in the former situation, and 1 in every 26 when in the latter. The comparative liability of the two classes of operation to phlebitis, is reversed in the lower extremity. In the thigh operations, according to the same writer, the employment of the flap was followed by phlebitis once in every 12·75 cases, and, in the leg, once in every 4 operations; whilst, after the circular, 1 in every 33·33 was attacked by the same disease when the amputation took place in the former site, and 1 in every 21·5 when it was performed in the latter.

These are very important statements, as displaying the greater chance of the occurrence of this formidable disease in the most dangerous amputations, when they are performed by the flap operation. The liability to secondary hemorrhage is about equal after both plans of operation. Thus, according to the author last quoted, in the flap amputations 1 in 12·68 was affected by it; whilst, in the circular one, 1 in 13·26 suffered from the same accident; and in Mr Alcock's practice, after the former method 1 in every 6, and, after the latter, 1 in every 5·4 was affected by secondary hemorrhage. As, however, this accident seldom proves fatal, excepting after the thigh operations, we should chiefly direct our attention to the chance of its occurrence after removal of this part. Dr M'Hardy gives 9 cases of it as having occurred out of 100 circular, and 9 out of 102 flap amputations of the thigh. We need not, therefore, consider the liability to secondary hemorrhage as affording any argument against the employment of either the one or the other method of operating.

But if the circular operation is less exposed to the occurrence of phlebitis, there can be no doubt that the advocates of the flap can bring forwards greater rapidity of execution, better stumps, a less liability to necrosis, and a shorter time of cure, for their favourite operation. With respect to the last of these advantages, Dr M'Hardy found that 1 stump in every 4·73 heals by granulation after the employment of the circular; whilst, after the flap operation, only 1 in every 7·85 did not unite by the first intention.

The question, then, which it is necessary to settle, before determining which description of operation we will perform upon any particular case, appears to be, whether the advantages of a better stump, and a quicker recovery, are sufficient to outweigh an increased liability to phlebitis. In amputations for diseased joints, in which phlebitis and secondary inflammations are of comparatively rare occurrence, and in which necrosis and conical stumps are, according to my own observation, most likely to take place, the flap operation appears, in most cases, to be indicated, more especially if the part to be removed be the upper extremity, or the patient be young. On the contrary, in traumatic amputations of the lower extremity, the circular operation would seem most advisable, as, in such cases, plenty of covering can be always obtained for the ends of the bones;

whilst, at the same time, we subject the patient to a less danger of phlebitis and secondary inflammations than by the other method. It seems somewhat strange, that, notwithstanding the long disputes upon the merits of these different plans of amputations, so few facts should have been collected; and I fear we shall have to wait for more detailed and accurate investigations, before we can venture fairly to decide upon their respective merits.

6. *The Influence of Sex upon the Results of Amputations.*

Individuals of different sexes differ so much in their employments, habits, and the other circumstances in which they are placed, that we might anticipate a considerable disproportion in their power of withstanding the dangers of an amputation. The following Table shows that the mortality in each hospital is usually much greater amongst the males than amongst the females :—

TABLE XXVI.

Shows the Mortality which has occurred after Amputations performed on Males and Females in different Hospitals.

	Males,			Females,		
	No.	Dead.	Av. Mortality.	No.	Dead,	Av. Mortality.
Newcastle Infirmary, ...	190	46	4·13	35	8	4·37
Glasgow Infr. (Lawrie),	216	88	2·45	55	11	5
Glasgow Infirmary,	85	26	4	15	4	3·75
Edinburgh Infirmary, ...	29	14	2·07	14	4	3·5
M. Malgaigne,	445	245	1·81	115	54	2·12
Total,	965	419	2·3	234	81	2·88

The greatest difference is observable in the Glasgow Infirmary report, as given by Dr Lawrie: according to it, the females having had but half the average number of deaths which had occurred amongst the males. It will be also remarked, that four times as many males as females suffer removal of the limbs,—a circumstance chiefly arising from the greater exposure of the former to accidental injuries. The next point in which we must compare the sexes, is in their comparative mortality after amputations performed at different sites. Not having the opportunity of examining the reports of the American hospitals, I am only able to present the results of the amputations of two Scotch infirmaries, which are given in Table XXVII.

TABLE XXVII.

A Comparison of the Mortality following different Amputations performed on Males and Females at the Edinburgh and Glasgow Infirmaries.

	Males,									Females,								
	Edinburgh Infirmary.			Glasgow Infirmary.			Total.			Edinburgh Infirmary.			Glasgow Infirmary.			Total.		
	No.	Dead.	Aver. Mort.	No.	Dead.	Aver. Mort.	No.	Dead.	Aver. Mort.	No.	Dead.	Aver. Mort.	No.	Dead.	Aver. Mort.	No.	Dead.	Aver. Mort.
Thigh,	17	8	2·12	27	7	3·85	44	15	2·93	8	3	2·66	9	3	3	17	6	2·83
Leg,	8	4	2	28	9	3·11	36	13	2·76	4	...	...	3	1	3	7	1	7
Shoulder,...	2	1	2	7	2	3·5	9	3	3	1	1	1	...	...	...	1	1	1
Arm,	1	...	...	13	5	2·6	14	5	2·8	...	...	...	2	...	...	2	...	...
Fore-arm,	1	1	1	10	3	3·33	11	4	2·75	1	...	...	1	...	...	2	...	...

Only in the leg operations have the amputations on the females been much more successful than on the other sex. The average mortality in the thigh amputations is greater in the former than in the latter, and in the arm, shoulder, and fore-arm operations, the numbers are too small to enable us to compare their results. It might, however, be expected that we should find a considerable difference in mortality between the sexes, when the operations upon them are classified according to the diseases for which they were required; and, to elucidate this point, the following statement has been compiled from the records of the Newcastle Infirmary. In reading it, it must be remembered that the sites are those of the diseases or injuries, and do not refer to the parts at which the limbs were removed.

TABLE XXVIII.

Comparison of the Success of Amputations performed on Males and Females at the Newcastle Infirmary.

		Females.					Males.				
		No.	Dead	Aver. Mort.	Cure.	Dth.	No.	Dead	Aver. Mort.	Cure.	Death.
Diseased joints and bones.	{ Knee and thigh,	9	2	4·5	55·2	19	40	7	5·71	48·25	14·85
	{ Foot and ankle,	7	1	7	65·66	60	42	2	21	50·09	22
	{ Wrist and hand,	2	...	...	47	...	6	2	3	40·5	7
Other diseases.	{ Leg and foot, ...	6	2	3	63	23	19	10	1·9	54·48	15·2
	{ Arm and elbow,	3	...	...	36·5	...	3	1	3	48·5	16
Traumatic amputations,.....	{ Leg and foot, ...	5	3	1·66	52	19	33	11	3	67·7	12·55
	{ Arm and elbow,	3	...	...	54·33	...	21	4	5·25	53·8	25·75

In the amputations for diseased joints and bones, or in that class in which, of all others, the patients are most favourably circumstanced for recovery, we here find the advantage on the side of the males. Thus, of 88 cases of these operations performed on the males, 11 died, or 1 in 8; whilst, of 18 females who suffered amputations for the same diseases, 3 perished, or 1 in 6. Or, if we compare them when classified according to the situation of the disease, the difference appears still greater,—the mortality amongst the males in the thigh operations being 1 in 5·71; whilst amongst the females it amounted to 1 in every 4·5. In the leg amputations, of the males only 1 death took place of 21, whilst of the females 1 occurred in every 7.

That there is a greater mortality amongst the females suffering amputations for this class of diseases, appears to be confirmed by the statements of Dr Lawrie. Thus, of 96 males whose limbs were removed for diseased joints and bones, 16, or 1 in every 6 died; whilst, of 35 females, 7 perished, or 1 in 5. That this excess of mortality does not arise, in the case of the females, from the shorter duration of the disease in them, is easily demonstrable. Thus, only one female is recorded in the operation books of the Newcastle Infirmary whose diseased joint had existed for less than one year, and death followed the amputation. No case amongst the females terminated fatally where the disease had lasted from one to five years;

but of four whose joints had been affected above that time, two died after the removal of the limbs, or 1 in 2. Neither does it appear to have arisen from greater debility occasioning death by the shock of the operation; for none of the deaths amongst the females took place within ten days after the performance of the amputations.

It will be seen, in Table XXVIII., that, after amputations for other diseases, the females have had the advantage in the Newcastle Infirmary, partly, I conceive, from their being less subject to those diseases which it is most dangerous to remove by the operation, and partly, also, we may suppose, from a less plethoric condition of body, enabling them to pass through the inflammatory periods occurring after an amputation with less danger than the other sex. Thus, of 17 cases of amputation for ulcerations of the leg, 12 were men, of whom 7 died, or 1 in 1.71; whilst of 5 women only 1 perished after the operation. If we class together all the amputations performed for pathological causes, the females seem, in a great degree, to have the advantage; thus, Malgaigne gives 280 cases of this operation on males, of which number 138 deaths took place, or 1 in 2.03, and 98 cases of females, of whom 44 died, or 1 in every 2.22; and Dr Lawrie states, that of 110 pathological amputations upon males, 29 died, or 1 in 3.8; whilst, of 41 females upon whom the same description of operation was performed, only 7 died, or 1 in 5.85.

In Table XXVIII., we should observe that the traumatic amputations had proved most fatal in the Newcastle Infirmary amongst the women. This is apparently an anomaly; for, according to Malgaigne, whilst of 165 traumatic amputations performed on males, 107 perished, or 1 in 1.54; of 17 operations performed for accidents on females, only 10 died, or 1 in 1.7; and, according to Dr Lawrie, the average mortality amongst the males for traumatic amputations, was, at the Glasgow Infirmary, 1 in 1.79; but amongst the females, only 1 in 3.5 did not recover from the effects of a similar operation.

To what conclusion, then, can we arrive, with respect to the influence of the sex of the patients upon the results of amputations? From the discrepancies upon this point observable in the reports of different hospitals, from the variety in the results of amputations performed for different diseases on the same sex, is it not probable that sex has of itself but little effect on the issue of an amputation; and that this disproportion in the mortality between the males and females, observable in some hospitals, is chiefly to be attributed to the difference in their habits and employments, or to the difference of the diseases for which the operation is required?

7.—*The Influence of Age upon the results of Amputations.*

The age of a patient is always an important consideration in determining upon the performance of an amputation, and the propriety of the operation often depends upon this point alone. How necessary, then, to have accurate ideas with respect to the amount of influence which age usually exercises; how requisite is it, that our

opinions upon this point should be based rather on facts than upon theories ; and that our practice should be guided rather by deductions from figures, than by hasty generalizations or vague impressions !

We see, by the following Table, the general results of amputations performed at different ages.

TABLE XXIX.
Shows the Mortality following Amputations at different Ages in the under-mentioned Hospitals.

	Under 10 Years.		10 to 20.		20 to 30		30 to 40.		40 to 50.		50 to 60.		60 to 70.		70 to 80		80 to 90.	
	No.	Av. Mor.	No.	Aver. Mort.	No.	Aver. Mort.	No.	Av. Mor.	No.	Av. Mor.	No.	Av. Mor.	No.	Av. Mor.	No.	Av. Mor.	No.	Av. Mor.
Liverpool North Hospital, Glasgow Infirmary, University College Hospital, Pennsylvania Hospital, Massachusetts Hospital, Newcastle Infirmary, }	...	...	6	...	11	11	11	5·5	7	1·4	8	4	5	1·66	...	...	...	...
	17	4·25	75	3·75	68	2·61	53	2·96	30	2	17	1·54	8	2	2	...	1	1
	6	...	16	5·33	17	8·5	10	3·33	9	4·5	3	...	4	...	1	...	...	...
	Under 20 Years.		13	13	26	3·71	22	3·1	16	2·28	2	...	...	...	...	...	...	...
	Under 20 Years.		13	13	31	3·5	9	3	10	5	3	3	...	...	1	...	...	...
	15	15	53	5·88	65	5	30	3	31	3·44	21	2·62	5	2·5	2	...	2	2
Total, ...	38	7·6	150	4·68	218	3·82	135	3·13	103	2·57	54	2·45	22	2·44	6	...	3	1·5

In addition to the above statements, we have the following from Malgaigne :—

TABLE XXX.
A Statement of the Mortality of Amputations performed at different Ages in the Hospitals of Paris, as given by Malgaigne.

2 to 5 years.			5 to 15 years.			15 to 20 years.			20 to 35 years.			35 to 50 years.			50 to 65 years.			65 to 80 years.		
No.	Dead	Av. Mor.	No.	Dead	Av. Mor.	No.	Dead	Av. Mor.	No.	Dead	Av. Mor.	No.	Dead	Av. Mor.	No.	Dead	Av. Mor.	No.	Dead	Av. Mor.
5	3	1·66	66	22	3	81	36	2·25	193	102	1·89	126	76	1·65	70	50	1·4	19	10	1·9

The age of the patient has evidently a considerable effect upon the result of an amputation. The greatest difference in mortality is observable in the Liverpool Northern Hospital, in which, of 17 cases of amputation under 30 years of age, only one died ; whilst of 13 between 50 and 70 years of age, 5 perished.

The mortality, it will be observed, does not increase in any regular ratio ; but the influence of age seems, as it were, to become less as we approach the extreme limits of life.

Thus, whilst 1 in every 7·6 has died of the persons suffering amputation who are below 10 years of age, and 1 in every 4·68 of those between 10 and 20, in the next decennial period only 1 in 3·82 sinks after the amputation. In Table XXX. the cases are differently classified from those in the table immediately preceding it ; and from it we learn, that whereas from 5 to 15 years of age is the

most favourable, below 5 years of age is one of the most fatal periods of life in which a patient can submit to the removal of a limb. Another remarkable circumstance, and one to which we shall afterwards have to refer, is, that in persons between 70 and 80 years of age, the mortality is much less than in those who are classed in the periods immediately preceding or following that time of life—in Table XXIX., none out of 6 cases having perished of those between 70 and 80; whereas, excepting in those below 10 years of age, no amount of mortality, equally small, can be remarked in any other period. In like manner, Malgaigne gives 1 in 1·9 as the average mortality between 65 and 80 years of age; whereas all the preceding periods beyond 20 years of age had exhibited a greater amount of death.

We have before usually found the greatest danger to life coexist with the longest time of cure; but in the next Table this rule appears curiously reversed. We have there, under 10 years of age, an average mortality after amputations of 1 in 15, and the period of cure 72·9 days; whereas, between 10 and 20 years of age, the average mortality is 1 in 5·88, and the time of cure only amounts to 51·58 days.

TABLE XXXI.

Shows the Time of Cure of Amputations performed on Patients at different Ages, together with the Mortality observed at different periods after the Operations at the Newcastle Infirmary.

	Under 10 years.	10 to 20.	20 to 30.	30 to 40.	40 to 50.	50 to 60.	60 to 70.	70 to 80.	80 to 90.
Average time of cure,	72·9	51·58	51·15	57·76	51·33	53·9	36·5	54	49
Average mortality } in 1st week, }	15	10·6	10·83	15	31	10·5	...	...	2
Do. in 2d & 3d week,	...	...	8·42	9·33	10	3·8	2·5	...	...
Do. after 3d week, ...	...	12	...	5	5·4	14	...	...	...

In order to contrast the influence of age upon the success of an amputation as observed when it is performed at different sites, I have constructed the next Table—the first part is formed from the records of the Newcastle Infirmary, the second part from Malgaigne's statements of the mortality in the hospitals of Paris, and consists solely of males.

TABLE XXXII.

Shows the Mortality following Amputations of different parts, performed on Patients of different Ages, as observed at the Newcastle Infirmary and in the Parisian Hospitals.

	Under 10 Years.	10 to 20 Years.	20 to 30 Years.	30 to 40 Years.	40 to 50 Years.	50 to 60 Years.	60 to 70 Years.	70 to 90 Years.	Newcastle Infirmary.
Lower extremity,.....	0 in 9	5·83	5·77	2·66	3·12	2·5	1·5	1	
Upper extremity,.....	6	6	3·66	5	6	5	0 in 1	0 in 3	
		2 to 5 yrs.	5 to 15.	15 to 20.	20 to 35.	35 to 50.	50 to 65.	65 to 80.	Malgaigne.
Thigh,.....	...	1	2·28	1·86	1·53	1·22	1	0 in 1	
Leg,.....	...	2	6	2·12	1·88	1·9	1·41	1	
Arm,.....	...	...	1·75	4	1·86	2·25	1·8	3	
Fore-arm,.....	...	...	2	0 in 1	5	2·66	3	0 in 1	

The effects of age are here very different upon a number of subjects undergoing amputation of the upper and of the lower extremities. In the latter class of operations the mortality seems to have gradually increased, with the exception of the period between 30 and 40 years of age, in which the amount of death is greater than in the subsequent period. In the amputations of the upper extremity no similar rule can be laid down; for the number of deaths is greater between 20 and 30, than between 60 and 90 years of age. Again, in Malgaigne's statement, in amputations of the thigh and leg the risk of death seems to increase with the age of the patient, excepting below 5 years of age; whilst in those of the arm, the number of deaths occurring in persons above 65 years of age is less than at any other period, excepting between 15 and 20 years. In the amputations of the fore-arm the same circumstance is observable, the mortality between 20 and 35 years of age being 1 in 5; whilst in the period most favourable in the graver amputations, viz. from 5 to 15 years of age, it is 1 in 2.

We have before observed the difference of mortality between the cases of pathological and traumatic amputations, and have seen how different are the results they furnish, even when examined under similar conditions of sex. It, therefore, becomes necessary to ascertain the effects of age upon each of these classes of operations separately. In Table XXXIII. will be found cases of pathological amputations as given by Malgaigne and Lawrie, and as extracted from the books of the Newcastle Infirmary, the operations at each place being classified according to the ages of the patients upon whom they were performed.

TABLE XXXIII.

A Statement of the Mortality of Amputations performed for Diseases, on Patients of different Ages, and at various Hospitals.

Years of Age.	Glasgow Infirmary.			Newcastle Infirmary.			M. Malgaigne.				Pathological Amputations.
	No.	Dead.	Av. Mort.	No.	Dead.	Av. Mort.	Years of Age.	No.	Dead.	Av. Mort.	
1 to 10,....	15	4	3.75	6	...	0 in 6	2 to 5,....	4	2	2	
10 to 20,....	48	5	9.6	30	2	15	5 to 15,...	57	15	3.8	
20 to 30,....	33	10	3.3	44	5	8.8	15 to 20,...	66	28	2.35	
30 to 40,....	30	8	3.75	18	7	2.57	20 to 35,...	128	63	2.03	
40 to 50,....	15	5	3	18	4	4.5	35 to 50,...	72	40	1.8	
50 to 60,....	4	1	4	16	5	3.2	50 to 65,...	40	29	1.37	
60 to 70,....	6	3	2	4	2	2	65 to 80,...	11	5	2.2	
70 to 80,....	...	...	...	2	...	...	...	...	...	...
80 to 90,...	...	...	...	1	...	...	...	...	...	...

From the above statements it is pretty evident, and the opinion is supported by the study of other operations performed for diseases, that whilst amputations for disease are most successful when performed on persons between 5 and 20 years of age, the chance of recovery of those under 5 years of age is comparatively small. It should be also remarked, that the increase of mortality in this class of amputations is not gradual; but that, after a certain period, what

had been at a previous age an operation of but small hazard, gradually assumes a most severe character. This turning-point is in these British hospitals at 20 years of age; but in the Newcastle Infirmary the mortality does not become excessive until after 30, when the amount of death which had been, up to that age, so dissimilar in the Glasgow and Newcastle Infirmaries, becomes afterwards more closely approximated. After the age of 30, the mortality seems as a general rule gradually to increase in all the hospitals, until the commencement of old age, when the danger usually becomes less; a smaller amount of death having occurred, both in the French hospitals and at the Newcastle Infirmary, after 70 years of age, than had been observed in the period immediately preceding that advanced time of life.

TABLE XXXIV.

Shows the success attendant on Amputations, performed for Diseases upon Persons of different Ages, as observed at the Newcastle Infirmary.

LOWER EXTREMITY.

	Diseased Joints and Bones.						Other Pathological Amputations.					
	Under 10 years	10 to 20 years.	20 to 30 years.	30 to 40 years.	40 to 50 years.	50 to 60 years.	10 to 20 years.	20 to 30 years.	30 to 40 years.	40 to 50 years.	50 to 60 years.	60 to 70 years.
Number,.....	6	23	37	13	13	6	4	3	3	2	6	3
Deaths,.....	...	1	2	5	13	1	1	2	2	0	3	2
Average Mort,..	...	23	18·5	2·6	4·33	6	4	1·5	1·5	...	2	1·5
Time of Cure,..	30	49·9	51·1	52·1	55·8	63·6	65	59	50	44	65·6	44
Mort. in 1 week,	...	23	37	13	...	...	...	3	3	...	6·	...
Do. after 1st week,.....	}...	...	36	3	4·33	6	4	2	2	...	2·5	1·5

TABLE XXXV.

Shows the success attendant on Amputations of the Upper Extremity, performed for Diseases upon Persons of different Ages, as observed at the Newcastle Infirmary.

UPPER EXTREMITY.

	10 to 20 Years.	20 to 30 Years.	30 to 40 Years.	40 to 50 Years.	50 to 60 Years	60 to 70 Years.	70 to 80 Years.	89 to 90 Years.
Number of cases,.....	3	4	2	3	4	1	2	1
Deaths,.....	...	1	...	1	1	...	...	...
Average mortality,.....	...	4	...	3	4	...	...	...
Average cure,.....	61	48	34	26	38·6	29	54	49
Mortality in 1st week,.....	...	4	...	...	4	...	...	...
" after 1 week,.....	...	...	...	3	...	...	...	...

In these Tables it is attempted to gain a more accurate idea of the hazard of the operation performed at different ages for certain diseases, than can be obtained from a more general classification.

In cases of amputations for diseased joints in the lower extremity, the increased mortality, after 30 years of age, is exceedingly striking; for of 32 cases of amputation performed on persons above that age, 9 perished, or 1 in every 3·55, whilst of 66 of those under that time of life, only 3 died, or 1 in 22. After 50 years of age the mortality becomes less than in the 20 years before that time; so that in persons

between 30 and 50 years of age, the amputations for diseased joints in the lower extremity have been least successful. How carefully, then, should we in these operations consider the time of life at which our patient has arrived before pronouncing a favourable prognosis! The mortality in the second week after the operation shows us, that it is in the occurrence of a less amount of secondary inflammations that the superior success of early and extreme age consists.

If we compare the average mortality during the second week after amputations for diseased joints, in persons between 30 and 50 years of age, with that occurring in the same period of life in traumatic amputations, we shall discover but little advantage to arise from the circumstance of the disease having previously existed; the mortality after the first week being, in the former class of amputations, 1 in 3·55, whilst in the latter it is 1 in 2·83. That the time required for cure also increases with the age is worthy of remark; each period between 10 and 50 years of age being marked by a very gradual increase, whilst below and above these periods the difference is very considerable.

Amongst amputations of the lower extremity performed for other diseases, a different law of mortality may be observed; and this we might be led to expect, on account of the subjects of the operations of which it is composed, not having been so much reduced by disease as those cases from which the other side of the Table has been formed. Amongst the other pathological amputations, the usual comparatively small amount of death from secondary disease in persons below 20 years of age is observable; but in the succeeding period, in which, amongst amputations of diseased joints, we remarked the mortality to be still comparatively small, we here find it to have risen to an equality with that of the most fatal age. It is curious that, amongst these amputations, the time of cure is as great below 20 years of age as at any future time, therein differing from the results obtained by the analysis of cases of amputation performed for diseased joints.

In Table XXXV. I have classed together all the pathological amputations of the upper extremity, the numbers of the operations performed for each disease being too small to admit of their separation. No regular increase in mortality corresponding with the age can be remarked. The fact, that only 1 out of 8 of these cases of amputation who were above 50 years of age died, whilst 1 out of 4·5 perished who were between 20 and 50, is valuable with reference to the operation of resection of the elbow joint. It teaches us to perform the latter operation during the earlier periods of existence, as there is both a greater chance of its being successful, and a less probability of recovery if amputation be resorted to; on the other hand, after 50 years of age, the hazard from the amputation decreases, whilst the danger from the removal of the joint becomes greater. It is worthy of observation, how slow the wound is in healing, below 20 years of age, amongst pathological amputations of

the upper extremity; and, however inexplicable the fact may be, it will be seen, by examining Tables XXXIV. and XXXVI., that at this early period of life, although the mortality is usually small, yet the time required for cure is generally higher than at any other period.

TABLE XXXVI.

Shows the success attendant on Amputations, performed for Accidents on Persons of different Ages, at the Newcastle Infirmary.

	Lower Extremity.							Upper Extremity.					
	Under 10 Yrs.	10 to 20 Years.	20 to 30 Years.	30 to 40 Years.	40 to 50 Years	50 to 60 Years.	80 to 90 Years.	Under 10 Yrs.	10 to 20 Years.	20 to 30 Years.	30 to 40 Years.	40 to 50 Years.	50 to 60 Years.
No. of cases,	3	8	12	8	10	3	1	6	15	7	3	3	1
" deaths	...	4	5	2	5	2	1	1	3	2	1	...	...
Aver. mort.,	...	2	2.4	4	2	1.5	1	6	5	3.5	3	...	...
Av. in 1st } week,..., }	...	2	12	...	10	...	1	6	...	7	...	...	...
Aver. after } 1 week,... }	...	...	2.75	4	2.25	1.5	...	...	5	6	3	...	...
Aver. cure,..	86.5	61.5	63.6	66	42.25	...	...	59	53.3	38.6	78	70.6	...

TABLE XXXVII.

Shows the Mortality following Amputations, performed for Accidents on Patients of different Ages, at the Glasgow Infirmary and Hospitals of Paris.

Ages.	Glasgow Infirmary.			Ages.	Lower Extremity.			Upper Extremity.			
	No.	Dead.	Av. Mort.		No.	Dead.	Av. Mort.	No.	Dead.	Av. Mort.	
Under 10,....	2	2 to 5 years,	1	1	1	M. Malgaigne.
10 to 20,.....	30	13	2.3	5 to 15 "	6	5	1.2	2	1	2	
20 to 30,.....	35	16	2.18	15 to 20 "	10	6	1.66	4	1	4	
30 to 40,.....	23	10	2.3	20 to 35 "	49	29	1.68	11	8	1.37	
40 to 50,.....	15	10	1.5	35 to 50 "	32	22	1.45	18	11	1.63	
50 to 60,.....	13	10	1.3	50 to 65 "	20	17	1.17	7	3	2.3	
60 to 70,.....	2	1	2	65 to 80 "	1	1	1	4	2	2	
70 to 80,.....	2	...	...	...	...	...	...	...	...	...
80 to 90,.....	1	1	1	...	...	...	...	...	...	...

The great mortality amongst cases of amputation performed on persons below 20 years of age, for accidents, at once strikes our attention, as we have previously found this the least fatal period of life amongst pathological amputations. It is, however, easily explained by looking at the time at which death occurred. It appears from Table XXXVI., that in all the fatal cases below 20 years of age, death took place within the first four days; and that out of seven amputations where the patients survived beyond that time, none were afterwards lost. There can be, therefore, little doubt that the great mortality observed amongst those of the same age at the Glasgow and Parisian hospitals, might be similarly explained. We have thus, in Tables XXXIV. and XXXVI., examined forty-four cases of amputations performed at the Newcastle Infirmary on the lower extremity, the subjects of which were below 20 years of age. Of these, 5 died within the first four days, or in the period of shock; whilst of 39 who survived the depression of the operation,

only 1 was subsequently lost, and this case was amongst the most unhealthy class of diseases. From this, the practical conclusion appears to be, that in cases of amputation, when the patients are below 20 years of age, we need scarcely fear the occurrence of phlebitis, or secondary inflammations; and that, although the patient is more apt, at this age, to sink from the double shock of an accident and subsequent operation, yet, if he survive this trial, his chance of recovery will be exceedingly good. The examination of the results of amputations of the upper extremity, seems to throw some doubt upon the truth of this rule; for, of 24 cases of the operation performed on this limb in persons below 20 years of age, only 1 died within the first four days, whilst of 23 who lived beyond the first four days, 3 afterwards perished. It should, however, be remembered, that persons at this period of life having usually the care of the machinery in factories, are especially liable to accidents of the upper extremity, complicated with severe injuries of other parts of the body; and it is, I believe, from this cause that so large a mortality is observable in Table XXXVI. As was before remarked, excepting where the patient has been prepared by previous disease, as in diseases of the joints, the wound of an amputation will usually be found longer in healing in those below 20 years of age, than in persons suffering the operation at a somewhat later period of life. Between 20 and 50 years of age, the mortality does not gradually increase in the traumatic amputations of the lower extremity; but it is less between 30 and 40 than in the period either immediately preceding or following that age. This fact is observable both in the Glasgow and in the Newcastle Infirmary reports. The danger is, however, less between 20 and 30 than between 40 and 50 years of age. But if, on the other hand, we divide, as in Malgaigne's report, this period into equal parts of fifteen years each, it will be found that but a small difference in mortality exists between the first and the second half of this thirty years. It will be useful for the practical surgeon to remember, in deliberating upon the removal of a leg for an accident, that from 30 to 40 is a more successful age than from 20 to 30, and that this latter period is, again, somewhat, but not very much, more favourable than from 40 to 50. The time of cure seems curiously to follow the rule of its being longest where the mortality is least: thus, between 30 and 40 years of age, it is 66 days; between 20 and 30, 63·6 days; and between 40 and 50 years of age, it is only 42·25 days. In the upper extremity, out of 13 cases of traumatic amputation between 20 and 50 years of age, 3 perished, or 1 in 4·33, a mortality considerably higher than what took place before that time of life. According to Malgaigne's statistics, this is the most dangerous period of life for removing the upper extremity for an accident; and this opinion is strengthened by Table XXXV., upon which we have before commented. After 50 years of age, the danger from the operation, when performed for injuries on the lower extremity, rapidly

increases ; thus differing from what we before remarked in the amputations for diseased joints, and in those performed for pathological causes on the upper extremity.

In traumatic amputations upon the upper extremity, the mortality, as seen by Malgaigne's statements in Table XXXVII., diminishes after 50 years of age, forming a striking contrast with the increased mortality in amputations of the lower extremity after that time of life. As we before found so great an influence exercised by the duration of a disease for which an amputation is performed, it is now necessary to ascertain at what age this influence is chiefly experienced. Table XXXVIII. has been constructed from the records of the Newcastle Infirmary, and is designed to illustrate this point with respect to amputations for diseased joints of the lower extremity.

TABLE XXXVIII.

Shows at what Age the duration of the Disease in a Joint has the greatest effect on the Mortality following the Amputation required for its removal, as observed at the Newcastle Infirmary.

	Under 20 Years.		20 to 30 Years.		30 to 40 Years.		40 to 50 Years.		50 to 60 Years.		
	No.	Av. Mort.	No.	Av. Mort.	No.	Av. Mort.	No.	Av. Mort.	No.	Av. Mort.	
Within 1 yr.'s duration,	{ 3	...	5	2.5	5	2.5	...	...	...	...	Thigh.
	{ 5	...	3	...	2	2	1	...	...	...	Leg.
1 to 2 years' duration	{ 1	...	5	...	...	...	2	...	...	...	Thigh.
	{ 1	...	6	...	1	...	1	...	...	...	Leg.
2 to 5 years' duration,	{ 2	...	...	...	1	1	1	...	...	...	Thigh.
	{ 3	...	3	...	1	...	1	1	...	...	Leg.
Above 5 yr.s' duration,	{ ...	...	2	...	3	1.5	2	2	2	...	Thigh.
	{ 1	...	3	...	...	...	2	...	...	...	Leg.

As former Tables have shown how great is the difference in the mortality between 20 and 30 years of age, according as we investigate it in the class of amputations for diseased joints, and in those amputations which are performed for accidents ; so, in Table XXXVIII., we find that all the deaths at that period of life had occurred amongst those who for the shortest time had suffered from disease. It will be advisable, therefore, in persons between 20 and 30 years of age labouring under incurable diseases of the joints, to delay the performance of amputation as long as the strength and other circumstances of the patient will permit, instead of resorting at an early period to the operation, on account of there being but little prospect of a natural recovery. In that time of life which, in amputations for diseased joints of the lower extremity, is most fatal—viz. from 30 to 50 years of age—we find also, that an amputation succeeds better if the disease has existed from one to five years, than if the operation be performed at an earlier stage of the disease. Thus, of 8 cases in which the illness had existed only one year, 3 died, or 1 in every 2.6 ; whereas, of 8 who had suffered from the diseased joint from one to five years, only 2 perished, or 1 in 4. Only two cases were operated upon who were above 60 years of

age; in both, the disease was of long standing, and in both the operation was successful.

In analysing the causes of death in secondary amputations, it was found that, whilst the patients undergoing that operation were not so liable to inflammatory affections as those suffering amputation immediately after the receipt of an accident; yet, that they were more likely to sink from exhaustion than cases of pathological amputation, and that this, in fact, constituted the chief danger of the amputation when performed at a considerable distance of time from the accident. From this we might be led to conclude, that the period of life in which the reduction of the strength of the patient by disease has the greatest effect in preventing subsequent inflammation, and, at the same time, that period in which the greatest power of resisting shock existed, we should find the most favourable for the secondary amputations; and this supposition Dr Lawrie's statistics confirm. Between 20 and 30 years of age, no deaths occurred out of 7 secondary amputations; whilst before that period, in which we found, by a previous Table, shock had so deadly an influence, 7 died out of 13, or 1 in every 1.85. Between 30 and 50 years of age, during which death most generally occurs from secondary inflammation, whether the operation be performed for traumatic or pathological causes, 12 died out of 16 cases of secondary amputation, or 1 in 1.33; whilst, beyond 50 years of age, of 8 cases, 6 also died, or 1 in 1.33. From 20 to 30 years is the age, then, at which we gain most by deferring, for the longest time, an amputation for an accident, both because the reparative process is most active at that period, and therefore there is a greater chance of a natural recovery, and also because there is less danger than at other times of life of the patient sinking from exhaustion immediately after the operation; whilst, by the continuance of suppuration, the chance of the secondary inflammations to which that age is liable after amputations, is removed. In patients below 20 years of age, we should remove the limb at an earlier period if there seems but small probability of a natural recovery from the accident; because there is less power in persons of that time of life of surviving the shock of the amputation, if it be long deferred, and we gain less in other respects by delay, on account of the small chance of the occurrence of phlebitis, or other secondary inflammations, after the amputation, when performed on persons of that early age. But the question arises, at what age are persons suffering compound fractures of the limbs least likely to reach that period when amputation can be safely employed? From an analysis of a number of such accidents to the lower extremities recorded in the operation books of the Newcastle Infirmary, I find that of persons below 20 years of age, 3 died out of 24, or 1 in 8, within the fourth and twenty-first day after the infliction of the injury. In none of these, therefore, could any chance of a favourable result, after amputation, have existed, otherwise that operation would have been attempted. Of 22 cases of compound fracture between

20 and 40 years of age, 4 died, or 1 in 5·5; whilst of 20 cases who were between 40 and 60 years of age, 2 perished, or 1 in 10; and of 4 persons above that time of life, none died. It should be, therefore, borne in mind, in attempting to save a dangerous case of compound fracture of the leg without amputation, when the person is between 20 and 30 years of age, that there is less chance of a patient reaching the period of suppuration, when secondary amputation, if required, is most successful; although, if that operation can be performed, there is greater probability of recovery than if it were performed upon a person below 20 years of age.

In persons between 30 and 40 years of age, I should imagine the attempt to save a compound fracture of the lower extremity was exceedingly hazardous, both on account of their liability to the secondary inflammations which are apt to follow the accident, and also because, if the secondary operation be permitted, the chance of recovery after the amputation is so small. As the amount of fatal disease between the fourth and twenty-first days after compound fractures has been so much smaller in persons between 40 and 60 years of age than in those of the period immediately preceding that time of life, we must either suppose that the surgeons of the Newcastle Infirmary had amputated a large number of the worst cases who were at this time of life, which they would have attempted to have saved if their ages had been less; or, otherwise, that persons of that age suffering severe accidents, are really less liable to fatal diseases between the fourth and twenty-first day after a compound fracture, than those between 20 and 40 years of age. But, from whichever of these causes this small amount of mortality has arisen, it is evident that accidents of greater severity, occurring in persons between 40 and 60 years of age, may be more safely deferred to the suppurative stage than is usually imagined. And, although the mortality in the case of secondary amputations above 50 years of age, is 1 in 1·33, yet we have found, by Tables XXXVI. and XXXVII., that an equally excessive amount of death takes place amongst those at that time of life who undergo the primary operation, when performed on the lower extremity; whilst in the class of diseased joints, to which secondary amputations are most similar, the number of deaths is remarkably small at that age. In order, however, to settle points of this importance, we should have large numbers of carefully observed and minutely classified cases, both of amputations and of compound fractures; for, I believe, there are few investigations more likely to prove useful than those which can be made regarding the age at which we may most safely treat a compound fracture without amputation.

I before stated my belief, that the discrepancies between the results of the practice of different hospitals respecting the mortality of the sexes, must be explained by the varying habits and occupations of the males and females in the districts to which the reports relate. The next Tables, however, show that, when analysed according to

age, an appearance of law can be obtained with respect to their comparative chances of recovery after an amputation.

TABLE XXXIX.

A Statement of the Mortality of Cases of Amputation, classified according to Age, Sex, and the cause requiring the operation, observed in the Newcastle and Glasgow Infirmaries.

	Pathological.				Traumatic.			
	Males.		Females.		Males.		Females.	
	Glasgow.	Newcastle	Glasgow.	Newcastle	Glasgow.	Newcastle	Glasgow.	Newcastle
	Av. Mort.	Av. Mort.	Av. Mort.	Av. Mort.	Av. Mort.	Av. Mort.	Av. Mort.	Av. Mort.
Under 20 years,.....	7.5	16	6	0 in 4	1.6	4.14	0 in 5	3
20 to 30 "	2.88	7.6	7	0 in 6	2.07	2.57	3	0 in 1
30 to 40 "	3.5	3.66	4.5	1.75	2.2	3.33	0 in 1	0 in 1
40 to 50 "	2.5	4.33	5	5	1.5	2.75	...	2
50 to 60 "	4	2.8	...	0 in 2	1.37	3	1	1
60 to 70 "	1.33	1.5	0 in 2	0 in 1	2	...	...	...
70 to 80 " .....	...	0 in 2	...	0 in 1	0 in 2	...	...	...
80 to 90 " .....	...	0 in 1	...	...	1	1	...	...

TABLE XL.

Shows the Mortality of Cases of Amputation, classified according to Age, Sex, and the cause requiring the operation, as observed in the Hospitals of Paris.

M. MALGAIGNE.

	1 to 5 Years.	5 to 15 Yrs.	15 to 20 Yrs.	20 to 35 Yrs.	35 to 50 Yrs.	50 to 65 Yrs.	65 to 80 Yrs.	
Males,.....	2	4	2.36	1.94	1.89	1.43	2	} Pathological.
Females,....	2	3.57	2.33	2.55	1.54	1.16	3	
Males,.....	1	1.33	2	1.62	1.51	1.35	1.66	} Traumatic.
Females,....	...	1	1	2.5	1.33	3	1.5	

Now, if we first examine the pathological amputations, we find that, below 20 years of age, when shock is chiefly to be dreaded, the females suffer more than the other sex. From 20 to 50 years of age the advantage is on the side of the females, excepting that at the Newcastle Infirmary, from 30 to 40, and in Paris from 35 to 50, the females have suffered less than the other sex. Beyond this time of life we have not the means of comparing them in the British hospitals; but at Paris the females present the greatest mortality from 50 to 65, and the males from 65 to 80.

In the amputations performed for accidents, the Glasgow report shows a greater amount of death in those below 20 years of age amongst the males; whilst at Newcastle and at Paris the same rule is observed as in the former class of operations. From 20 to 35 the females keep the advantage; but after this period of life there is a greater amount of success amongst the males.

8. *The influence of Season on the results of Amputations.*

THERE are few circumstances whose effects upon the results of operations are more obvious, and there are few to which less attention has been directed, than the influence of season. In this part of our investigations, I can bring forward but few authorities in support of my own conclusions; and this is the less to be regretted, since, from the variations in the weather in different places at the same time, it is probable the records of different hospitals would show very opposite results. In Tables XLI. and XLII. I have given the months in which deaths took place, after amputations of the limbs, at the Newcastle Infirmary, the operations being classified according to the cause which required their performance.

TABLE XLI.

Shows the Number of Deaths which took place, after Amputations of the Lower Extremity, in each month, at the Newcastle Infirmary.

	Diseased Joints & Bones.			Other Diseases.			Traumatic Amputations.			Total.		
	Within 4 Days.	4 to 21 Days.	After 21 Days.	Within 4 Days.	4 to 21 Days.	After 21 Days.	Within 4 Days.	4 to 21 Days.	After 21 Days.	Within 4 Days.	4 to 21 Days.	After 21 Days.
January,.....	1	...	1	2	...	1	3	...
February,.....	1	...	...	...	...	1	...	...	1	1
March,.....	1	...	...	...	...	...	1	...	...	2
April,.....	2	2	1	...	2	1	...	...	...	2	4	2
May,.....	...	1	1	1	1	1	1	1	...	2	3	2
June,.....	2	...	1	2	...	1	4	...
July,.....	1	...	2	...	...	2	1	...
August,.....	2	...	...	2	...
September,.....	1	...	1	...	...	1	1	...
October,.....	...	1	...	...	...	...	...	1	1	...	2	1
November,.....	1	...	...	...	1	...	...	1	...	1
December,.....	1	1	...	1	...	...	2	1

TABLE XLII.

Shows the Number of Deaths which took place in each month, after Amputations of the Upper Extremity, at the Newcastle Infirmary.

	Diseased Joints & Bones.			Other Diseases.			Traumatic Amputations.			Total.		
	Within 4 Days.	4 to 21 Days.	After 21 Days.	Within 4 Days.	4 to 21 Days.	After 21 Days.	Within 4 Days.	4 to 21 Days.	After 21 Days.	Within 4 Days.	4 to 21 Days.	After 21 Days.
January,.....	2	...	...	2
February,.....
March,.....	1	...	...	...	...	...	1	...
April,.....
May,.....
June,.....	...	2	...	...	...	...	...	1	...	...	3	...
July,.....	1	...	1	1	...	1
August,.....	1	...	...	...	...	...	1	...	...
November,.....	1	...	...	1	...	...

We find, then, that the months which have been most fatal to persons suffering amputation, are April, May, and June. Of the cases of amputation of the lower extremity, 20 deaths had occurred in this quarter of the year; whilst, in no other similar period, had the mortality exceeded 8. In the cases of the operation performed upon

the upper extremity, the difference is less perceptible, an equal number of deaths having occurred in each of the three first quarters of the year.

We might have supposed, that the depressing effects of cold would have given a greater tendency to death from shock within the winter months, but this is not the case. In those cases of amputation which are least liable to sink from exhaustion, viz. in the pathological class, the only deaths which occurred within the first four days after the operation, were in the second quarter, and this is chiefly observable in the amputations of the lower extremity. Of the traumatic amputations, the greatest number of deaths had taken place within the first four days within the second and third quarters of the year, whilst only 1 patient had perished within that period in the first and last quarters of the year.

If we consider the greater number of deaths occurring between the fourth and twenty-first days as arising from inflammatory complaints, we shall find that the spring is most liable to induce these affections. Thus, according to Tables XLI. and XLII., in the second quarter 14 deaths took place, in the first 5 deaths; whilst in each of the remaining quarters only 4 deaths had occurred. June is the most fatal month, no less than 7 deaths between the fourth and twenty-first days after the amputation being recorded in it, or nearly double the number that is observed in the whole of the summer and autumn quarters.

Amongst those who had survived the operation 21 days, the greatest number of deaths took place in the first quarter of the year, and the smallest mortality was observed in the third. In the spring, 4 deaths took place, and in the autumn only 3 fatal cases were remarked after the twenty-first day.

In the following Table the mortality is shown with respect to the months in which the operation was performed, and the cases are likewise divided according to age.

TABLE XLIII.

Shows the mortality which followed amputations performed for diseased joints and bones in each month, at the Newcastle Infirmary, separating the amount of death within four days from that which occurred afterwards.

DISEASED JOINTS AND BONES.

	LOWER EXTREMITY.								UPPER EXTREMITY.							
	Under 30 Years of Age.				Above 30 Years of Age.				Under 30 Years of Age.				Above 30 Years of Age.			
	No.	Mor. in 4 days.	Mor. aft. 4 days.	Av. Cure.	No.	Mor. in 4 days.	Mor. aft. 4 days.	Av. Cure.	No.	Mor. in 4 days.	Mor. aft. 4 days.	Av. Cure.	No.	Mor. in 4 days.	Mor. aft. 4 days.	Av. Cure.
January,	4	...	...	37	2	...	2	132	1	...	...	54	...	...	...	...
February,	5	...	...	64.5	6	...	...	58	...	...	...	...	...	...	...	...
March,	4	...	4	52	5	5	2	32	2	...	...	64.5	2	...	...	42
April,	7	7	6	50.6	7	...	3.5	45.2	1	...	...	58	...	...	...	...
May,	4	...	...	36.6	3	...	...	44	1	...	...	24	1	...	...	16
June,	7	...	...	56.6	2	...	...	...	1	...	1	...	1	...	1	...
July,	5	...	...	45.4	1	...	1	...	...	...	...	...	1	...	...	36
August,	4	...	...	41.7	2	...	...	50.5	...	...	...	...	...	...	...	...
September, ...	9	...	...	41.4	1	...	...	65	...	...	...	...	...	...	...	...
October,	7	...	...	38.8	3	...	1.5	...	...	...	...	...	1	...	...	24
November,	5	...	...	72.2	...	...	...	...	...	...	...	...	...	...	...	...
December,	5	...	...	55.2	1	...	...	30	...	...	...	...	1	...	...	38

Of those who suffered amputation for diseased joints and bones below the age of 30, no deaths had taken place, except amongst those operated upon in March and April, as regards amputations of the lower; and none, excepting amongst those whose amputations were performed in June, as regards those of the upper extremity. This is worthy of remembrance, as it is usually in our power to select a time for the performance of the operation upon such cases. In the healthy months no deaths had taken place out of 60; whilst in the 3 months above mentioned as fatal ones, 4 deaths had occurred in every 12 amputations, or 1 in every 3.

It would appear, however, that the seasons have a very different effect upon the constitution in other places, as, according to Malgaigne, amongst the cases of pathological amputation performed in the hospitals of Paris, of those below 20 years of age, 50 per cent. died in the winter, 40 per cent. in the autumn, 36 per cent. in the spring, and 35 per cent. in the summer.

At the Newcastle Infirmary, of those above 30 years who suffered amputations for diseased joints or bones, the months of March and April are again characterised by great mortality, 5 having died in them out of 14 cases of amputation, or 1 in every 2·8; but we also find January, July, June, and October exhibiting a certain amount of mortality. When required, then, to fix a time for performing amputation for diseased joint in the case of a person above 30 years of age, we should always, in this part of the country, avoid, if possible, its performance in March, April, or October, selecting chiefly the summer or the winter months.

TABLE XLIV.

Shows the Success following Amputations, performed for Ulcers and other Diseases, in each month, at the Newcastle Infirmary.

AMPUTATION FOR ULCERS AND OTHER DISEASES.

	Jan.	Feb.	Mar.	Apr.	May.	June	July.	Aug.	Sept.	Oct.	Nov.	Dec.
LOWER EXTREMITY.												
Number of cases,.....	2	...	3	3	2	3	5	...	3	2	...	2
Mortality in first 4 days,.....	...	...	...	...	2	...	...	...	...	...	...	...
" after 4th day,.....	2	...	1	3	1	1·5	5	...	...	2	...	2
Average cure,.....	37	...	...	63·5	...	30·	54·6	...	51·5	100·	...	...
UPPER EXTREMITY.												
Number of cases,.....	...	1	1	2	...	...	...	1	1	1	...	...
Mortality in first 4 days,.....	...	...	...	...	...	...	...	1	...	...	...	...
" after 4th day,.....	...	1	...	...	...	...	...	...	...	...	...	...
Average cure,.....	...	...	49·	48·	...	...	...	...	44	29	...	...

Here we find the amputations performed for ulcers and other pathological causes in March, as unsuccessful as were those for diseased joints in the same month. Those performed in April have been more fortunate; but the two following months exhibit a vast amount of death, 4 having perished out of 5. The summer is the only quarter of the year in which the mortality has been moderate, only 2 deaths being recorded out of 10 operations.

In all pathological amputations, then, we discover a great effect, produced by the different seasons in which they are performed, and the explanation of the fact is well worthy of attention. But we are unable to bring forwards any theories worthy of notice. It is evident, that the occurrence of the diseases producing death must be regulated by certain laws; and yet, from want of more minute statements of the diseases causing death, the period of their attacks, and the state of the weather at the time they were first observed, we are unable to point them out. In every hospital the operations should be most minutely and carefully registered, in order that the observations made in its wards, might indicate to the practitioners of the neighbourhood the seasons in which, with least risk, these operations can be performed.

In the traumatic amputations, although we have not the power of selecting the time at which we will remove a limb, yet the study of the influence of the seasons upon their results is likely to be exceedingly valuable, both in enabling us to anticipate particular diseases, and also in directing us with respect to the propriety of immediate or secondary amputation.

TABLE XLV.

Shows the success following Amputations for Accidents according to the Months in which they were performed at the Newcastle Infirmary.

TRAUMATIC AMPUTATIONS.

	LOWER EXTREMITY.								UPPER EXTREMITY.							
	Under 20 Years of Age.				Above 20 Years of Age.				Under 20 Years of Age.				Above 20 Years of Age.			
	No.	Mor. in 4 days.	Mor. aft. 4 days.	Cure.	No.	Mor. in 4 days.	Mor. aft. 4 days.	Cure.	No.	Mor. in 4 days.	Mor. aft. 4 days.	Cure.	No.	Mor. in 4 days.	Mor. aft. 4 days.	Cure.
January, .....	...	...	...	...	5	5	4	61·5	...	...	...	...	2	...	...	78
February, .....	...	...	...	...	2	...	2	...	...	...	...	...	1	...	...	70
March,	1	...	...	94	1	...	...	44	1	...	...	57	1	...	...	77
April, .....	...	...	...	...	1	...	...	86	1	...	...	...	...	...	...	...
May,	1	1	...	...	4	...	2	52	4	...	4	69	1	...	...	65
June, .....	...	...	...	...	3	3	2	...	3	...	3	68	2	...	2	36
July,	3	1·5	...	...	2	...	...	71·5	3	3	...	52	...	...	...	...
August,	2	...	...	34	4	...	2	...	2	...	...	73·5	...	...	...	...
September,	1	...	...	...	4	4	1·5	54	2	...	...	27	...	...	...	...
October,	1	...	...	77	1	...	...	72	1	...	...	76	1	...	...	26
November,	1	1	...	...	2	...	...	36	2	...	...	53·5	3	3	...	40
December,	1	...	...	96	4	...	1·33	82	2	...	2	33	2	...	2	82

In all calculations respecting the mortality following traumatic amputations, it is a matter of the greatest moment to separate the deaths according to the time after the operation at which they took place; for it is evident that those who sink from the shock of an accident, cannot equally display the influence of circumstances with those who perish from subsequent disease.

Of those who had undergone the removal of the lower extremity, and who were under 20 years of age, none died after the fourth day; but, in the case of amputations of the upper extremity, 2 deaths took place, and these occurred amongst those operated upon in the

two months we before remarked as so unhealthy, viz. in May and June. Of the cases of amputation above 20 years of age, with respect to the upper extremity 2 deaths took place after the fourth day, and of these 1 had the arm removed in June and the other in December. In the amputations of the lower extremity, in those above 20 years of age, May and June seem to have been, as usual, exceedingly fatal; but the other quarters of the year do not present the same amount of success we found them to exhibit in the former Tables. Thus, if we divide the numbers contained in this class of amputations according to the quarters of the year in which they were performed, we shall find that 1 case in every 3·5 died after the fourth day in the first three months, 1 in 2·33 in the second, 1 in 2·25 in the third, and 1 in 2·33 in the fourth quarter.

From this, then, we may conclude, that although the amputations performed in the second quarter of the year, viz. in April, May, and June, are most likely to prove unsuccessful in traumatic amputations; yet in the case of the lower extremity, in those above 20 years of age, the increase in mortality will be very little above that of the other periods of the year.

It will be observed, on comparing Table XLV. with the two Tables preceding it, that although the spring is by far the most fatal to all amputations; yet, that the pathological amputations performed in the earlier months of that period are more unsuccessful than those performed in June, whilst the contrary is remarked in those requiring the operation on account of accidents.

I have also classified the amputations performed at the Newcastle Infirmary according to the trades of the patients, but have not published the results for the following reasons.

1st, From the occupations of the patients not being noted either in the general registers of the hospital, nor in the books of the surgeons, I have had no means of verifying the correctness of, or detecting the errors in, the account of the operation books; and 2dly, as, in many instances, the occupation is only stated in general terms, such as mechanic or labourer, the want of exactness appeared to me to deprive the results of much of the interest which would otherwise have been connected with them.

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